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# The Engineer.

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VOL. CXXXVI.—No. 3523] LONDON: FRIDAY EVENING, JULY 6, 1923 [PRICE {WITH SUPPLEMENTS} ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

**Assistant Engineer Required** by the GOVERNMENT of the GOLD COAST for the PUBLIC WORKS DEPARTMENT, for a tour of not less than 12 nor more than 18 months' service. Salary £480, rising to £720 a year by annual increments of £30, and thence to £920 a year by annual increments of £40. Outfit allowance of £60 on first appointment. Liberal leave in England on full salary. Free quarters and passages. Candidates, about 35 years of age, preferably single, must be qualified civil engineers, have had special experience in surface water and land drainage work and surveying.
Apply at once by letter, stating age, qualifications, whether married or single, and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/12,100. 2925

**Assistant Engineer Required** for the PUBLIC WORKS DEPARTMENT of the GOVERNMENT of the STRAITS SETTLEMENTS, for three years' service, with prospect of permanency. Salary 425 dollars a month, rising to 606 dollars a month by annual increments of 25 dollars a month, plus a temporary non-pensionable allowance of 10 per cent. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., and its purchasing power in Malaya is considerably less than that in the United Kingdom. Free passages provided.
Candidates, aged 25 to 35, unmarried, must be Associate Members of the Institution of Civil Engineers, and have had at least three years' practical experience (exclusive of pupilage) as engineering assistants under an engineer who is a member of the Institution of Civil Engineers.—Apply at once, by letter, giving brief details of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/11,956. 2924

**Executive Engineer Required** by the GOVERNMENT of SIERRA LEONE for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' continuous residential service, with possible extension. Salary £480, rising by annual increments of £30 to £720 per annum, and thence to £920 a year by annual increments of £40. Liberal leave in England on full salary. Free quarters and passages. Candidates, age 25 to 35, preferably unmarried, must have served articles with a Corporate Member of the Institution of Civil Engineers or possess the Diploma of some recognised Engineering College which exempts candidates for the Associate Membership from taking the Institution Examination. Must be good Draughtsmen, capable of Designing and Carrying Out Buildings, Bridges and other Engineering Structures, and of Taking Out Quantities and Preparing Detailed Plans and Estimates. Must be competent to Execute Surveys and to Lay Out and Construct Roads. Should have had practice and general experience as Civil Engineers on the Construction of Roads, Buildings and other Public Works.
Apply at once by letter, stating age, qualifications and experience, and whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/12,098. 2987

## MINING ENGINEERING EXHIBITION.

### The South Wales Institute of Engineers.

In the
DRILL HALL (Dumfries-place), CARDIFF,
From
NOVEMBER 29 to DECEMBER 8, 1923
(both dates inclusive).
Open from 2 p.m. to 8 p.m. each day.

The Council of the South Wales Institute of Engineers invites APPLICATIONS for SPACE in the above Exhibition. The last date for receiving applications is AUGUST 31, 1923.
The Drill Hall has been booked from November 21 to December 14, 1923, so as to allow exhibitors sufficient time for the erection and dismantling of exhibits.
The Exhibition will comprise the following exhibits:
SCHEDULE OF EXHIBITS.
SECTION 1.
Scientific, Measuring and Recording Instruments as applied to all branches of Engineering.
SECTION 2.—STEAM.
Water Softening and Cooling Plant, Boilers and Equipment.
Pipes, Valves, Separators, &c. Drawings or Models of Modern Engines.
Governors and Safety Devices, &c.
SECTION 3.—ELECTRICAL.
Motors of various kinds and Models of Winders.
Switchgear, Cables, Controllers, &c.
Electrical Tools and other Appliances.
Overhead Lines, Small Motors, Electric Cranes.
Telephones and Wireless Apparatus, &c. &c.
SECTION 4.—MECHANICAL.
Mechanical Transmission of Power Above and Below Ground, and Plant and Equipment connected therewith.
Bearings, Clutches, Ropes, Belts, Gearing, &c.
Air Compressing Plant.
SECTION 5.—WORKSHOP APPLIANCES.
Machine Tools (Small), Pneumatic Tools.
Hydraulic Tools, &c. &c.
SECTION 6.—GENERAL.
Shaft Signalling. Devices to Prevent Overwinding.
Models of Pit Cages, Tram Tipplers, and Decking Devices.
Models of Coke Ovens, By-product and Recovery Plant.
Coal-cutting and Conveying Machines.
Models of Screening, Coal Washing and Sorting and Stone Dusting Plant.
Pumping Plant, Couplings, &c. &c.
Exhibits shall be as far as practicable arranged under their various Sections, but exhibitors will be allowed, when exhibiting under more than one Section, to group their exhibits on one stand.
Forms of application for space, ground plan, &c., will be forwarded on application to MARTIN PRICE, Secretary, The South Wales Institute of Engineers, Institute Buildings, Park-place, Cardiff. 2979

## UNIVERSITY OF DURHAM.

### Armstrong College,
NEWCASTLE-UPON-TYNE.
LECTURER IN MECHANICAL ENGINEERING.

The Council of Armstrong College invite APPLICATIONS for a LECTURESHIP as above. Salary £300-£350, according to qualifications. University degree or equivalent. Duties commence 1st October, 1923. Lecturer required to teach Mechanical Drawing, supervise work in laboratories and undertake preparation of necessary drawings. Practical experience essential. Ten copies of application and of not more than three testimonials must reach the undersigned not later than 21st July, 1923.

J. Y. T. GREIG,
Registrar,
2872 Armstrong College.

## The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE

A Large Ironworks in Yorkshire
(With One Four-Page and One Two-Page Supplement).

The Navigation Congress.

The Royal Agricultural Show at Newcastle.

Specifications and their Uses.

The Air Congress.

The Rapid Corrosion of Condenser Tubes.

Six Months' Variations in the Prices of Engineering Materials.

PUBLIC NOTICES

### University of Leeds.
CHAIR OF MINING.

The PROFESSORSHIP of MINING in the University will fall VACANT at the end of the present Session upon the resignation of Professor Granville Poole. A new appointment, taking effect on the 1st October, 1923, will be made in due course. The salary attached to this appointment will be £1000 a year. Further information may be obtained from the REGISTRAR, The University, Leeds. Inquiries should reach him not later than the 9th July. 2826

### University of Liverpool.
Session 1923-1924.
FACULTY OF ENGINEERING.

DEAN: Prof. T. B. ABELL, O.B.E., M.Eng., R.C.N.C., Ret., M. Inst. N.A.

Prospectus and full particulars of the following may be obtained on application to the REGISTRAR:—Engineering, Thermodynamics of Heat Engines, Strength of Materials, Electrical Engineering, Civil Engineering, Naval Architecture, Metallurgy, Geology, Marine Engineering, Design and Drawing, Refrigeration, Mathematics, Physics, Chemistry. 2041

### Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for:
TWO 10-TON STEAM TRAVELLING CRANES.
Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 29th June, 1923.
A fee of £1 1s. will be charged for the specification, which is not returnable.
Tenders must be submitted not later than Noon on Friday, 13th July, 1923.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
R. C. VOLKERS,
2929 Secretary.

### The Great Indian Peninsula Railway Company.

The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely—

| | Fee for Specification. |
|---|---|
| 1. FIRE-BRICKS | 7s. 6d. |
| 2. POINTS and CROSSINGS, &c. | 5s. |
| 3. BRASS SHEETS, COPPER, TUBES, &c. | 5s. |
| 4. BOLTS, NUTS, RIVETS, &c. | 10s. |
| 5. FLANGED COPPER PLATES, COPPER RODS and INGOTS | £1 |
| 6. PLATELAYERS' TOOLS | 2s. 6d. |
| 7. CAST IRON POT SLEEPERS | £1 |
| 8. RAILWAY TICKETS | 10s. |
| 9. GIBS and COTTERS | 2s. 6d. |
| 10. STEEL FISH BOLTS, CHAIR BOLTS, &c. | 7s. 6d. |
| 11. CRANK AXLES | 10s. |

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.
The fee should accompany any application by post. Cheques and Postal Orders should be crossed and made payable to the Great Indian Peninsula Railway Company.
Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Fire-bricks," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 17th July, 1923.
The Directors do not bind themselves to accept the lowest or any Tender.
R. H. WALPOLE,
Secretary.
Company's Offices,
48, Copthall-avenue, E.C. 2,
London, 4th July, 1923. 2985

PUBLIC NOTICES

### Aberdeen Corporation Water-Works.
EXTENSIONS, 1920.
CONTRACT NO. 12.—NEW AQUEDUCT.

The Town Council of Aberdeen are prepared to receive TENDERS from competent persons willing to enter into a contract for the MANUFACTURE and DELIVERY of about 3 MILES of 40in. Diameter PIPES and SPECIALS of the following alternative types, viz.:—
(a) CAST IRON.
(b) MILD STEEL (Lap-welded).
(c) REINFORCED CONCRETE (Spun and Ordinary).
The drawings may be inspected and specification, schedule of quantities and form of Tender obtained, on and after 12th July, 1923, on application at the Water Engineer's Office, 41½, Union-street, Aberdeen. Early application is desirable and no specification will be given out after 20th July.
For each specification of each type a deposit of Five Pounds sterling will be required, which sum will, after a Tender has been accepted, be returned to the tenderer, provided that he shall have sent in a bona fide Tender, based on the drawings, specification and schedule of quantities provided, with the schedule of quantities fully priced out in detail, and shall not have withdrawn the same.
Tenders, on the forms prescribed and enclosed in securely sealed envelopes, endorsed "Tender for New Aqueduct Piping," are to be addressed to the undersigned. No Tender delivered after 5 p.m. on the 21st July, 1923, will be considered.
The Town Council do not bind themselves to accept the lowest or any Tender.
GEORGE MITCHELL, M. Inst. C.E., F.G.S.,
Water Engineer.
Water Engineer's Office,
41½, Union-street, Aberdeen,
3rd July, 1923. 2942

### Aberdeen Corporation Water-Works.
EXTENSIONS, 1920.
CONTRACT NO. 13.—NEW AQUEDUCT.

The Town Council of Aberdeen are prepared to receive TENDERS from competent persons willing to enter into a contract for the TRANSPORTING, LAYING, and JOINTING of about 3 MILES of 40in. PIPING and ANCILLARY WORKS between Banchory and Crathes.
The drawings may be inspected and specification, schedule of quantities, and form of Tender obtained, on and after 12th July, 1923, on application at the Water Engineer's Office, 41½, Union-street, Aberdeen. Early application is desirable and no specification will be given out after 20th July.
For each specification a deposit of Five Pounds sterling will be required, which sum will, after a Tender has been accepted, be returned to the tenderer, provided that he shall have sent in a bona fide Tender, based on the drawings, specification, and schedule of quantities provided, with the schedule of quantities fully priced out in detail, and shall not have withdrawn the same.
Tenders, on the forms prescribed and enclosed in securely sealed envelopes, endorsed "Tender for Aqueduct Pipe Laying," are to be addressed to the undersigned. No Tender delivered after 5 p.m. on 21st July, 1923, will be considered.
The Town Council do not bind themselves to accept the lowest or any Tender.
No person should Tender unless thoroughly experienced in the actual construction of extensive public works.
GEORGE MITCHELL, M. Inst. C.E., F.G.S.,
Water Engineer.
Water Engineer's Office,
41½, Union-street, Aberdeen,
3rd July, 1923. 2943

**"THE ENGINEER" WANTED.**

WANTED, a COPY of "THE ENGINEER" Dated February 6th, 1920.—Address, P1000, The Engineer Office. P1000

PUBLIC NOTICES

### East Indian Railway.

The Directors are prepared to receive up to Eleven o'clock a.m. on Wednesday, the 25th July, TENDERS for the SUPPLY of—
COVERED GOODS WAGONS.
Copies of the specification can be obtained at the Company's offices on payment of £1 1s. each. This fee will not be returned.
G. E. LILLIE,
Secretary.
73-76, King William-street, London, E.C. 4,
5th July, 1923. 2990

### Liverpool Corporation Water-Works.
CONTRACT FOR VALVES FOR OSWESTRY NEW FILTER BEDS AND STOCK.

The Water Committee of the Liverpool Corporation are prepared to receive TENDERS from manufacturers for the SUPPLY of certain SLUICE and other VALVES from 2in. to 24in. internal diameter inclusive.
The plans may be inspected and copies of the specification and form of Tender obtained on and after Wednesday, 4th July, 1923, at the Water Engineer's Office, Alexandra Buildings, 55, Dale-street, Liverpool, upon payment of the sum of Two Guineas, which amount will be refunded upon receipt of a bona fide Tender and the return of the documents issued.
Tenders, endorsed "Tender for Valves," are to be sent through the post in a sealed envelope, addressed "Chairman of the Water Committee, Town Clerk's Office, Municipal Buildings, Liverpool," so as to be delivered not later than Twelve o'clock Noon on Tuesday, the 24th July, 1923.
The Water Committee do not bind themselves to accept the lowest or any other Tender.
WALTER MOON,
Town Clerk.
Municipal Buildings, Liverpool,
30th June, 1923. 2932

### London and North-Eastern Railway Company.

The Directors are prepared to receive TENDERS for CONSTRUCTION of the TIMBER WORK required for the completion of the new North Side Stalths at Blyth.
Plans and specifications may be seen and detailed quantities and form of Tender obtained on personal application at the branch office of Mr. C. F. Benzough, the Company's Chief Engineer for the North-Eastern Area, at Forth Banks, Newcastle-on-Tyne, on and after July 2nd.
Sealed Tenders, marked "Tenders for New North Side Stalths, Blyth," must be sent to the Joint Secretaries at Marylebone Station, London, N.W. 1, not later than 9 a.m. on Monday, July 23rd.
The Directors do not bind themselves to accept the lowest or any Tender.
JAMES McLAREN,
C. F. THURSTON,
Joint Secretaries.
Marylebone Station,
3rd July, 1923. 2970

### Southport, Birkdale and West Lancashire Water Board.
TENDER FOR CAST IRON PIPES.

The Southport, Birkdale and West Lancashire Water Board are prepared to receive TENDERS from competent manufacturers for the SUPPLY and DELIVERY of about 250 TONS of 9in. diameter CAST IRON PIPES and IRREGULARS, manufactured in accordance with the British Standard Specification.
Conditions of contract, specification and form of Tender may be obtained from the undersigned, and to whom sealed Tenders must be delivered not later than 10 a.m. on 31st July, 1923.
The Water Board do not bind themselves to accept the lowest or any Tender.
C. BURTON EDE, Assoc. M. Inst. C.E.,
Engineer and Manager.
14, Portland-street, Southport,
July 3rd, 1923. 2960

### State Electricity Commission of Victoria.
TENDERS FOR PLANT.

TENDERS are hereby INVITED for the SUPPLY of the following MATERIAL for the Morwell Power Scheme.
Copies of Tender form and specification, &c., will be available for inspection and purchase upon application to
The Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.
SPECIFICATION NO. 23/23.—TRANSFORMERS.
CHARGE.—10s. for two copies of Tender form, specification, contract conditions, &c., complete. This charge will be returned on receipt of a bona fide Tender.
A third or any further copies will be supplied for the sum of 5s. each, but this charge is not returnable.
PRELIMINARY DEPOSIT.—A preliminary deposit of £50 is required to be lodged with each Tender.
The Commission does not bind itself to accept the lowest or any Tender.
Tenders, on prescribed forms, properly addressed and endorsed, must be delivered to the undersigned in Melbourne not later than Noon, 23rd August, 1923.
R. LIDDELOW,
Secretary,
State Electricity Commission of Victoria,
Melbourne, Victoria,
2795 Australia.

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## PUBLIC NOTICES

### The Great Indian Peninsula RAILWAY COMPANY.

The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely—

Fee for Specification.

CARRIAGE UNDERFRAMES and STEEL BODIES for MOTOR and TRAILER COACHES, and with FOUR-WHEEL BOGIES for TRAILER COACHES ONLY ..... £1

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.

The fee should accompany any application by post. Cheques and Postal Orders should be crossed and made payable to the Great Indian Peninsula Railway Company.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Carriage Underframes, &c.," or as the case may be, not later than Eleven o'clock a.m., on Tuesday, the 31st July, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

E. H. WALPOLE,
Secretary.

Company's Offices,
48, Copthall-avenue, E.C. 2,
London, 4th July, 1923. 2984

### The Metropolitan Asylums Board

invite TENDERS for the DRY-DOCKING of the RIVER AMBULANCE STEAMER "WHITE CROSS" and REPAIRING HULL and FITTINGS, in accordance with specification prepared by Mr. Thomas Cooper, M.I.C.E., M.I.M.E., Engineer-in-Chief to the Board.

Specification, conditions of contract, and form of Tender may be obtained at the office of the Board, Victoria Embankment, London, E.C. 4.

Tenders, addressed as noted on the form, must be delivered at the office of the Board not later than 10 a.m. on Wednesday, 18th July, 1923.

G. A. POWELL,
2971 Clerk to the Board.

### Tyne Improvement Commission. EXTENSION OF TIMBER JETTY, HOWDON YARD.

The Tyne Improvement Commissioners are prepared to receive TENDERS for the EXTENSION of a TIMBER JETTY at their Repairing Yard, Howdon-on-Tyne.

Copies of the form of Tender, conditions of contract, specification and drawing, may be obtained on application to the undersigned on payment of a deposit of £2 2s., which will be returned on receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed on the cover "Tender for Extension of Jetty," must be addressed to the undersigned and delivered to him not later than Noon on Friday, the 20th of July, 1923.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
RICHARD AUGHTON,
General Manager.

Tyne Improvement Commission Offices,
Bewick-street, Newcastle-upon-Tyne,
2nd July, 1923. 2940

### Uxbridge Union.

The Guardians invite QUOTATIONS for SUPPLYING and INSTALLING at the Union Institution, Hillingdon, near Uxbridge, a WEIGH-BRIDGE of weighing capacity of 10 to 15 tons.

Particulars as to the proposed site of the weigh-bridge can be obtained from the Master of the Union Institution, Hillingdon.

Quotations to be sent to me, the undersigned, by 6 p.m. on the 24th July, 1923.

A. R. WOODBRIDGE,
Clerk to the Guardians.

Guardians' Office,
38 High-street, Uxbridge. 2986

### Wigan Union.

The Guardians of the Poor of the Wigan Union invite TENDERS for the SUPPLY, DELIVERY, and ERECTION of ONE ELECTRICAL VERTICAL PUMPING PLANT, HEATING and DOMESTIC HOT WATER SUPPLY APPARATUS, ALTERATIONS of BUILDINGS, ADDITIONS and MAKING a WELL, at the Poor Law Infirmary, Billinge, near Wigan.

Copies of specification and general conditions may be obtained from me, the undersigned, on payment of a fee of £3 3s., which will be returned upon receipt of a bona fide Tender, and plans can be inspected at this office at any time during office hours.

Tenders, to be sealed and endorsed "Tender for Plant, Billinge Infirmary," to be delivered to me not later than 10 a.m. on Thursday, the 9th August, 1923.

The Guardians do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
H. GORDON ACKERLEY,
Clerk.

Victoria Buildings,
King-street, Wigan,
2nd July, 1923. 2955

### Borough of Bedford. ENGINEERING ASSISTANT.

APPLICATIONS are INVITED for the APPOINTMENT of an ENGINEERING ASSISTANT in the Borough Engineer and Surveyor's Office.

Salary will be at the rate of £190 per annum, with bonus on the scale adopted by the Council, calculated at the basic rate of £70 per annum, subject to a rise or fall of £2 13s. 10d. for every complete five points by which the cost of living varies from 130. The present value of the bonus is £43 2s.

Applications, in candidates' own handwriting, stating age, together with full particulars as to experience (and enclosing copies of not more than three recent testimonials), endorsed "Engineering Assistant," to be sent to the undersigned not later than Thursday, 26th July, 1923.

Preference will be given to candidates who have had a training in a municipal engineer's office.

Canvassing will disqualify.

N. GREENSHIELDS,
Borough Engineer and Surveyor.

Town Hall, Bedford,
4th July, 1923. 2976

### Severalls Mental Hospital, COLCHESTER.

WANTED, RESIDENT ASSISTANT ENGINEER. Must be capable man, steady and thoroughly reliable, fully qualified to take charge of power station, consisting of steam boilers, steam and oil engines, dynamos, switchboard, pumps, &c.

Candidates must be capable of supervising and undertaking repairs, &c., at such times as may be necessary. Only first-rate men will be considered.

Wages £5 per week. A cottage, together with firing and light, is provided within the Hospital grounds, and for which a reasonable weekly charge is made.

The appointment is subject to the terms of the Asylums Officers' Superannuation Act, 1909.

Applications, stating age (which should not exceed 30 years), experience, &c., and accompanied by copies of three recent testimonials, to be made upon forms obtainable by enclosing stamped addressed envelope to the MEDICAL SUPERINTENDENT. 2954

July 3rd, 1923.

### The Sudan Government Railways

REQUIRE the SERVICES of a DISTRICT LOCOMOTIVE SUPERINTENDENT. Age 26/32, preferably single. Candidates should have been trained on British railway or in a locomotive builders' works, and should have good knowledge of the working of a locomotive department. A.M.I.C.E. degree desirable.

Commencing salary £E480, rising to £E900 per annum eventually. Strict medical examination.

Application by letter to CONSULTING MECHANICAL ENGINEER, Sudan Government Railways and Steamers, 5, Northumberland-avenue, W.C. 2. 2956

## SITUATIONS OPEN

WANTED for Indian Tea Estate, ENGINEER ASSISTANT, with Gas Engine Experience preferred; first agreement 4 years, passage paid; subsequent agreements 3 years. Salary, Rs. 250 monthly; Annual increase, Rs. 25 up to Rs. 500; annual bonus, Rs. 200; allowances, Bungalow, medical attendance and pony or allowance Rs. 30 a month. Commission on profits and 8 months' furlough with full pay and return passage after 5 years' service.

Apply, No. 250, Robertson, Stationer, High-street, Perth. P7708 A

WANTED for Large Firm of Crane Makers, REPRESENTATIVE, to Take Charge of London Office. One having good connection and capable of interviewing and discussing projects and who can influence new business. State age, salary, and experience.—Box No. 41, Macrae's Advertising Agency, 93, Hope-street, Glasgow. 2876 A

WANTED, MANAGER for Engineering Works in East Anglia, specialising in Manufacture of Roller Bearings, &c. Previous experience in this class of work essential. State age, experience, and salary required. References.—Address, 2980, The Engineer Office. 2980 A

WANTED, WORKS MANAGER, by Firm of Boiler-makers. None but first-class, up-to-date and progressive men need apply.—Address, stating age, experience, in the first instance, 2847, The Engineer Office. 2847 A

ENGINEER SALESMAN for Birmingham District. Well educated, good technical and practical training, sales experience. Salary about £300.—Apply, stating age and details of experience, to HANS RENOLD, Ltd., Burnage Works, Didsbury, Manchester. 2981 A

ENGINEER.—WANTED by a Leading Engineering Concern in Calcutta, an ENGINEER, to Take Charge of Engineering Sales Department. Age not to exceed 32, unmarried. Must be really well educated and have first-class machinery selling experience. Anyone with previous experience in either Bombay or Calcutta preferred. Salary commencing Rs. 750 per month, with good prospects.—Write, with copies of testimonials and, if possible, copy of photograph, which latter will be returned, to Z. H. 947, c/o Deacon's, Leadenhall-street, E.C. 3. 2947 A

ENGINEER, with Experience in Harbour Constructions, also an experienced Designer of Reinforced Concrete, REQUIRED by Firm of Civil Engineers and Contractors.—Address applications, stating full particulars of previous experience, salary required, and references, 2927, The Engineer Office. 2927 A

METALLURGICAL CHEMIST REQUIRED AT ONCE for large Iron and Steel Works. Must have good experience in all qualities of Basic Open-hearth Steel, and should have knowledge of up-to-date specification requirements.—Address, 2941, The Engineer Office. 2941 A

OLD-ESTABLISHED FIRM of CONSULTING ENGINEERS REQUIRE a First-class MECHANICAL ENGINEER. Must have extensive experience in Designing Rotary Cement Plants covering Electricity and Power Transmission, Powdered Fuels and Oil Feeding, Automatic Feeding Devices, Elevators and Laying Out for Steam Shovels. Must be quick draughtsman and good at figures for estimating. Excellent prospects for the right man. A knowledge of civil and chemical engineering would be an advantage. Only highly technical men need apply.—Write, stating age, where experience gained, diplomas or degrees, if any, credentials (copies), and salary required, Box 150, Sell's Advertising Offices, Fleet-street, E.C. 4. 2949 A

STEAM POWER ENGINEER REQUIRED for industrial technical office. Must have had power plant and drawing-office experience and have knowledge of modern Boiler, Engine and Turbine Practice. Progressive appointment for the right man. Applicants should give full particulars of experience and state age, salary required and date when free.—Address, P7699, The Engineer Office. P7699 A

STEEL (Electric) FOUNDRY MANAGER. First-rate MAN REQUIRED, with thorough commercial, metallurgical, and works experience. Applications in confidence, stating age, experience, present position, salary required, when free.—Address, 2950, The Engineer Office. 2950 A

TECHNICAL ASSISTANT REQUIRED for Expanding Firm of Patent Agents. Good address indispensable. Opportunity to rise to executive position.—Write, stating qualifications and salary required, Box 343, c/o Judd's, 87, Gresham-street, E.C. 2933 A

WANTED, a DRAUGHTSMAN, with Good Knowledge of and experience in Woodcutting Machinery.—Address, 2962, The Engineer Office. 2962 A

WANTED for Engineering Firm in the Midlands, DRAUGHTSMAN, used to Power Station Layouts and Constructional Steel Work. State age, experience, and salary required.—Address, 2936, The Engineer Office. 2936 A

DRAUGHTSMEN REQUIRED, with Experience in Crane and Structural Work.—Apply, stating age, experience, and salary desired, to HERBERT MORRIS, Ltd., Loughborough. 2959 A

DRAUGHTSMEN REQUIRED, with Good Technical and shops training and experience in (A) Aeroplane and (B) Aero-engine Design. Salary 40s. to 80s. per week plus cost of living bonus (equivalent present totals £3 8s. 11d. to £6 4s. 4d.). Ex-Service men preferred.—Applications should be addressed to the SUPERINTENDENT, Royal Aircraft Establishment, South Farnborough, Hants. 2983 A

DRAUGHTSMAN, Tramway and Railway Rolling Stock.—Apply (letter only), stating age, experience, and salary, to MANAGER, The English Electric Co., Ltd., Box 36 Preston. 2974 A

DRAUGHTSMAN, Used to Steel Bridge Construction, for temporary work in London.—Write, stating experience and salary required, to Box 300 at Hornecastle's, 60, Cheapside, E.C. 2. P7697 A

DRAUGHTSMAN WANTED in South of England for Centrifugal Pump and Refrigerating Work. State age, particulars of experience, and wages required. —Address, 2973, The Engineer Office. 2973 A

DRAUGHTSMAN WANTED by Engineering Firm in the City, with Pipe Work Design Experience. —Address, stating age, experience, and salary required, 2952, The Engineer Office. 2952 A

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## SITUATIONS WANTED (continued)

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For continuation of Small Advertisements see page 3

July 6, 1923.—Vol. CXXXVI.

# THE ENGINEER.

## A Seven-Day Journal

### Niger Valley Irrigation.

The French scheme for irrigating the Niger Valley is already meeting with an opposition that seems likely to retard its execution for an indefinite period. The idea of the proposal is to convert the arid region through which the Upper Niger passes into a second Egypt, capable of producing all the cotton that may be needed by French weavers, as well as the cereals required to supplement the home production. Plans were carefully prepared and the scheme was incorporated in the programme of colonial development presented by Monsieur Sarraut, the Minister of the Colonies, who was able to awaken so much enthusiasm in this ambitious proposal that there appeared to be little doubt of its early realisation. The opening in September next of the railway between Thiès and Kayes, at the point where the Niger begins to be navigable, was expected to offer an excellent opportunity for putting the irrigation scheme on a financial basis. It appears, however, that in certain quarters opinion is becoming hostile to the expenditure of vast sums of money upon colonial enterprises, and it is argued that there is really no necessity to irrigate lands for the production of cotton when it can be grown by the "dry" method of cultivation. Already the quantity of cotton produced in this way by native and European growers is rapidly increasing, and is commanding good prices in France, and if it be found that "dry farming" will provide all that is needed there is evidently little hope of carrying out an irrigation scheme involving an expenditure far greater than can at present be afforded.

### The French Air Force.

Following upon the programme for the development of the British Air Force, announced in the House of Commons last week, the French Chamber of Deputies voted immediately a considerable increase upon the original estimates for the creation of new air squadrons. The coincidence may be regarded as remarkable; but, nevertheless, the French insist that there is nothing in this sudden heavy expenditure which may suggest an idea of retaliation, and if they have awakened to the fact that the present air force is insufficient, it is, they say, because their eyes are fixed upon the disquieting progress of commercial aviation on the other side of the Rhine. Still, the supposed secret developments elsewhere do not prevent the French from suggesting the inadvisability of carrying on a struggle for air supremacy and from proposing that the British and French should arrange for a limitation of military and naval aeroplane construction, or, better still, that the two countries should co-operate for their common defence. The suggestion made in France that each country should be allowed free inspection of what is being done by the other and profit from mutual progress would certainly tend to a more rapid development of aircraft construction.

### Impact Effect on Railway Bridges.

Our contemporary, *Modern Transport*, in its issue for Saturday last, was responsible for the announcement that Mr. Conrad Gribble, of the chief engineer's department, North-Eastern area, London and North-Eastern Railway, had been appointed Chief Engineer in charge of experiments to be made by the Department of Industrial and Scientific Research in connection with the question of impact stress on bridges. With this work the British Engineering Standards Association and the railway companies are also to be identified, and each will contribute towards the cost. We may take advantage of this notification to clear up a general misunderstanding that has prevailed as to the report, dated December, 1920, and issued two years ago, by Major—now Lieut.-Colonel—H. A. L. Mount, one of the Railway Inspection Officers, dealing with 181 tests on twenty typical railway bridges. It should be known that during the period of Government control of the railways, and when the activities of the Ministry of Transport were at their highest and the desire for standardisation rampant, an Advisory Committee was appointed to revise the Requirements as to New Railways, the last issue of which was dated February, 1914. A Sub-committee was subsequently set up to deal with bridge requirements, and the tests covered by Major Mount's report were those made by this Committee and shown in Appendix 3 to the report. Therein were also submitted alternative curves for small spans up to 50ft., and for spans of from 50ft. to 200ft. Where confusion has arisen is that it has generally been assumed that the curves so submitted were going to be adopted. This is not so; the diagram, Appendix 3, said that they were "suggested for consideration." It is, therefore, good news that the matter is, as we have always understood was to be the case, to be investigated further.

### The Southern Railway Organisation.

On the 1st inst. the organisation for the Southern Railway came into operation. The most remarkable feature of the system is that the railway has no administrative head. Since the company came into being at the beginning of the year, each of the three sections has retained its former general manager. What seems likely is that, at all events for the present, there will be joint general managers in the persons of Sir Herbert Walker and Sir Percy Tempest. It is safe to assume that Sir William Forbes will retire. Since Mr. David Cooper, of the Glasgow and South-Western, left at the end of last year on the amalgamation of that company, Sir William has been the *doyen* of the general managers, having held his present post for twenty-four years. Another noteworthy feature is the very minor part the former Brighton officers take in the new scheme. The only name of note appearing in the list of chief officers is Mr. H. A. Sire, the Brighton goods manager, who is to be the chief commercial manager. The London and South-Western has done very little better. Only two chief offices, besides the secretaryship—the latter was rendered vacant as the result of the death of the former secretary to the Brighton, who had been appointed to the Southern Railway—fall to the South-Western. These are those of the chief engineer, Mr. A. W. Szlumper, and of the docks and marine manager, filled by his son, Mr. Gilbert Szlumper. On the other hand, the South-Eastern and Chatham has more than held its own. Mr. Maunsell is the chief mechanical engineer; Mr. G. Ellson, the deputy chief (civil) engineer; Mr. A. D. Jones, the running superintendent, and Mr. E. C. Cox, the chief operating superintendent.

### The Chief Mechanical Engineer, Southern Railway.

The announcement that Mr. R. E. L. Maunsell was to be the chief mechanical engineer of the Southern Railway and responsible for the design, construction, purchase and maintenance of all locomotives, carriages, wagons and road vehicles, afforded much satisfaction to the many friends of that gentleman. Mr. Maunsell served his time under that fine locomotive engineer, Mr. H. A. Ivatt, at Inchicore, and, later, went to Horwich under Mr. Aspinall, who subsequently made him the shed foreman at Fleetwood. Whilst holding that office he made a name for himself by the quick way in which he cleared up the complete wreckage of a London and North-Western excursion which left the rails on July 1st, 1893, when running at high speed over the sharp curve then existing at Poulton-le-Fylde. The following year he went to the East Indian Railway, but returned to Inchicore in 1896 to succeed Mr. R. Coey as works manager when that gentleman was promoted to be locomotive superintendent on Mr. Ivatt's going to Doncaster. In 1913 Mr. Maunsell went to the South-Eastern and Chatham Railway. The latest type of locomotive for which Mr. Maunsell is responsible is the 2–6–0, which was the subject of an article in our issue of February 23rd last, and of which fifteen are being built. It is due to Mr. Maunsell that it should be observed that the design for a suitable engine for the South-Eastern section has been handicapped by the low carrying capacity of some of the bridges, that over the Thames at Charing Cross in particular.

### Agricultural and General Engineers.

It is announced by the directors of Agricultural and General Engineers, Limited, that the trading for the year ended March 31st, 1923, of the associated companies which form the combine, resulted in a loss of approximately £150,000. For the previous year the loss amounted to about £217,000. The position, the directors state, is accounted for by the engineering lock-out, the depression in agriculture and the writing off of stock. Proposals are shortly to be submitted to the shareholders for a re-organisation of capital.

### The Boilermakers' Dispute.

The Boilermakers' Society is now ballotting its members to decide whether the dispute with the Shipbuilding Employers' Federation in connection with the Overtime and Night Shift Agreement shall be continued. The ballot papers are to be returned on Monday. According to the rules of the Society, a two-thirds majority will be required to continue the dispute. At a late, and, as it seems to many an unpropitious, hour, the General Council of the Trades Union Congress has entered the field in support of the Society. It urges the view, already advanced by the boilermakers themselves, that the Agreement prejudiced the Society's interests to a disproportionate extent as compared with the other unions which have accepted it, and pleads that the case should be submitted to arbitration under the Industrial Courts Act.

### Railwaymen's Wages.

While the question of the status and rates of pay of the shopmen has not yet been completely settled, fresh difficulty has arisen in the railway world in connection with the companies' proposals regarding the conditions of working and wages of the outdoor staff. The companies desire the withdrawal of the standard day, the withdrawal of overtime payment for all night-work between 10 p.m. and 4 a.m., the establishment of the right to call men on for split duties of not less than two hours at the higher rate for Sunday work, and the entire withdrawal of the mileage system of payments. It is probable that the railway trade unions will determine to make a very strong fight against these proposals.

### Southampton's Automatic Exchange.

Last Saturday an automatic telephone exchange was opened at Southampton, and the previously existing manual exchange taken out of service. A public telephone exchange was first introduced in Southampton in 1886, and, after several removals, during which various improvements in the working of the system were made, notably the introduction of the first underground telephone cables in the district in the year 1897, the present exchange was installed, in 1902, in the specially designed telephone building which is still used. The automatic plant has been set up in the same building as the magneto equipment, which it will supersede. Local calls on the new exchange are effected without the intervention of an operator. The dial with which the call is made is on the telephone instrument, and over it is a movable finger plate containing ten holes, through which are seen, on the fixed dial, the numbers 0 to 9. The subscriber, after lifting the receiver, operates the dial by placing a finger in the number hole corresponding to the first digit of the number required and pulling the finger plate round to the finger stop. The finger plate, on being released, returns to its normal position. Each succeeding digit of the number required is signalled in the same way. Mechanism is thus set in motion at the exchange, causing the line of the calling subscriber to be connected to the required number and the called subscriber's bell to ring at regular intervals until an answer is obtained.

# The Penistone Works of Cammell Laird and Co., Limited.

No. I.

IN May, 1864, Charles Cammell and Co., Limited, purchased from Messrs. Bensons, Adamson and Garnetts the works at Penistone known as the Yorkshire Iron and Steel Works, which had previously been employed for steel converting, refining, rolling, &c. The works were situated on the north-east side of the Manchester, Sheffield and Lincolnshire Railway, known later as the Great Central Railway, and now forming part of the London and North-Eastern system. The works, with such modifications as to keep them in line with the times, remained in their original condition until 1917, when Cammell Laird and Co., Limited, were called upon to make a large increase in the output of steel for war purposes. With this object in view more land was acquired, and about 40 acres were purchased on the south-west side of the railway on which to build a complete steel melting department. In order to expedite the finishing processes by the rolling mill plant, it was also decided practically to rebuild the whole works on the other side of the railway line so as to bring them in every respect up to date and to make them comparable with the most efficient works in any part of the world.

A further development was decided upon in 1918, when arrangements were made to consolidate the three separate tire plants already in existence in other sections of the works, into one organisation on the new side at Penistone. The original works, together with the various extensions, now form one complete whole, in which railway material, rolled sections, billets, &c., are produced from the raw material to the finished product. A general plan of the works is given in Fig. 1, and the various sections are described in detail with the aid of numerous illustrations in what follows.

The works are situated immediately adjoining the London and North-Eastern and London, Midland and Scottish joint station at a height of 695ft. O.D., on the main line of the first-named, connecting Manchester with London and, in the second case, on the line between Huddersfield and Sheffield and thence to London. There is also from Penistone a railway connecting directly with Hull and Barnsley. It will therefore be noted that from the point of view of transport and railway facilities generally the works are particularly well situated for steel manufacture. From the general plan it will be seen that the various sections of the works have direct connection with the main line and that each department is efficiently served by sidings.

Although the modernisation and re-equipment of the works reduced the amount of hand labour very considerably, the addition of the melting shops and tire plant resulted in a net increase of persons employed. To accommodate these men and their families the company purchased about 200 acres of land situated about half a mile from the works and at an altitude of 928ft. above sea level. A portion of this area was laid out for a model village, the first section of which, consisting of ninety-four cottages designed and built by Mr. Herbert Baker, F.R.I.B.A., is now completed. High building costs and labour difficulties have prevented the continuation of this scheme for the present, and the whole of the houses have been handed over to the Urban District Council, under the control of which they now are.

In the detailed description of the works which follows we have endeavoured, as far as possible, to trace the course of the raw material through the various departments to the finished product. With this object we shall commence with the new steel melting department on the south-west side of the railway.

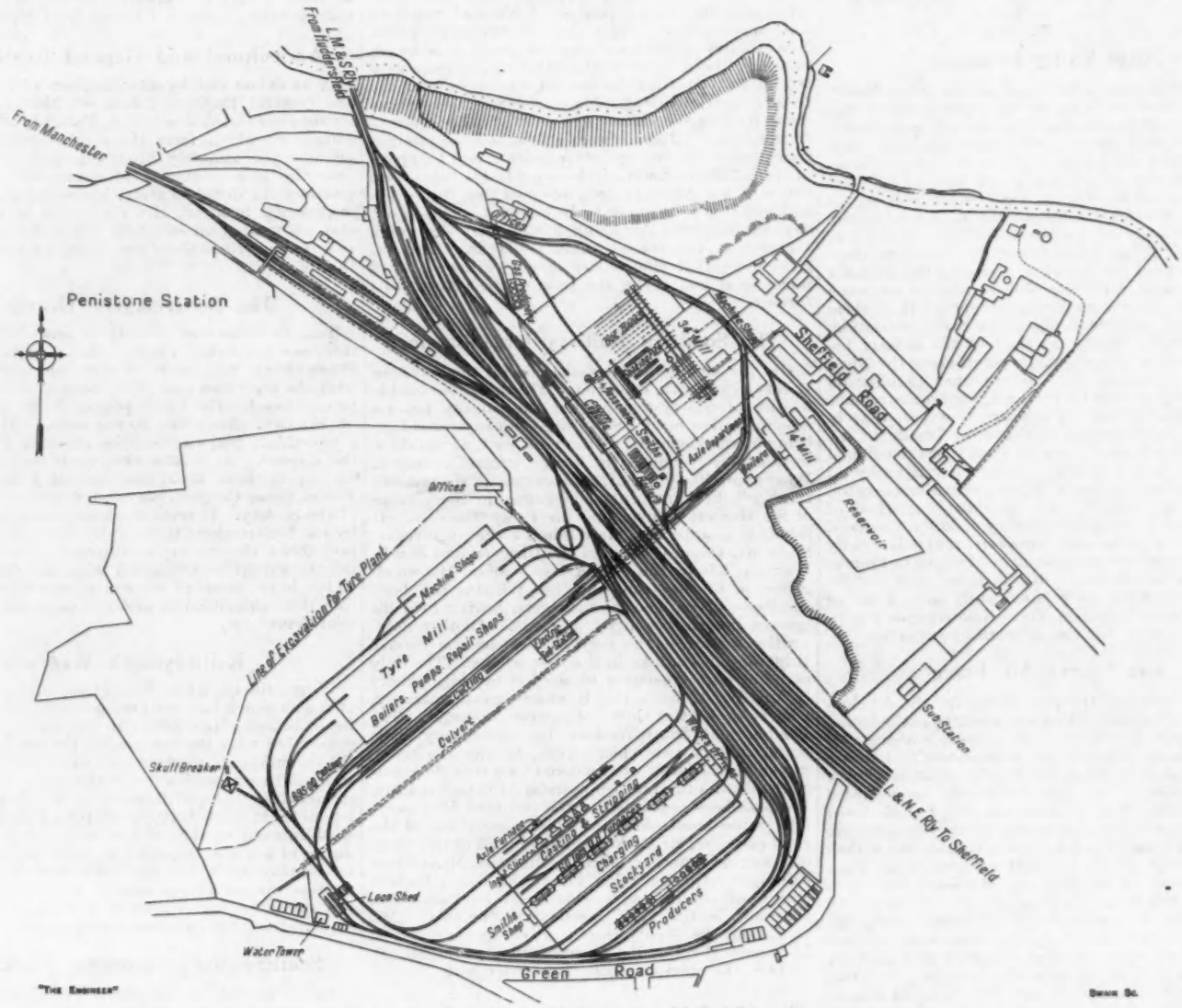



FIG. 1—GENERAL PLAN OF THE WORKS

## STEEL MELTING DEPARTMENT.

The main buildings consist of four bays, each 561ft. long between the centres of the end columns, thus :—

| | |
|---|---|
| Stockyard bay— | |
| Roof span | 79ft. 4½in. |
| Crane span | 76ft. |
| Height, floor to eaves | 50ft. 6in. |
| Height, floor to crane track | 40ft. 6in. |
| Furnace bay— | |
| Roof span | 68ft. |
| Crane span | 63ft. 7in. |
| Height, floor to eaves | 50ft. 6in. |
| Height, floor to crane track | 40ft. 6in. |
| Height, floor to furnace stage | 14ft. |
| Casting bay— | |
| Roof span | 80ft. |
| Lower track, crane span | 73ft. 6in. |
| Upper track, crane span | 76ft. |
| Height, floor to eaves | 67ft. 8in. |
| Height, floor to lower crane track | 41ft. 8in. |
| Height, floor to upper crane track | 59ft. 11in. |
| Service bay— | |
| Roof span | 60ft. |
| Crane span | 56ft. |
| Height, floor to eaves | 50ft. 6in. |
| Height, floor to crane track | 40ft. 6in. |

The buildings, which are illustrated by sectional drawings and half-tone engravings in our Supplements, are of steel covered with corrugated sheets, a considerable portion of the roofs being glazed. They were supplied and erected by Sir Wm. Arrol and Co., Limited, of Glasgow. The area covered by the main buildings is 17,952 square yards, and their cubic contents 375,163 cubic yards, with a total weight of structural steel work of 5250 tons. All the bays are well ventilated and have wide and continuous lanterns for the full length. The crane equipment is as follows :—In the stockyard bay, two 10-ton "Arrol" magnet cranes and one 10-ton "Wellman" magnet crane. In the furnace bay, two "Wellman" 5-ton overhead slewing charging machines, each equipped with 10-ton auxiliary crab. In the casting bay, two 100-ton "Arrol" ladle cranes with 25-ton auxiliary hoist, and two 5-ton "Wellman" stripping cranes, having a stripping power of 100 tons. The above four cranes are situated on the lower track. There is also one 10-ton overhead crane on the upper track for general service. In the service bay there are two 5-ton "Craven" overhead cranes. The whole of these cranes are electrically operated at high speeds.

The furnaces were designed and built by Wellman, Seaver and Head, Limited—now the Wellman Smith Owen Engineering Corporation, Limited. Their main particulars are as follows :—

| | |
|---|---|
| Air chequer chamber, each side | 20ft. by 9ft. by 22ft. 6in. high |
| Gas chequer chamber, each side | 20ft. by 6ft. 11in. by 22ft. 6in. high |
| Air ports, two at each end | 3ft. wide by 20in. high |
| Gas ports, one at each end | 18in. square |
| Air reversing valve | 42in., Butterfly type |
| Gas reversing valve | Dyblie, 36in |
| Diameter of chimney stack, inside lining | 5ft. |
| Height of stack | 150ft. |
| Furnace cross section | 14ft. wide by 8ft. 2in. high |
| Size of bath | 35ft. by 14ft. |
| Space between blocks | 37ft. |

The furnace bay is equipped with three 60-ton basic open-hearth furnaces and three similar furnaces with acid lining. The longitudinal span of the columns in front of the furnace is 93ft. 6in., which enables the whole of the furnace foundation to be totally clear of the foundations for the building columns. The furnace stage is 89ft. wide and, neglecting the area occupied by the furnaces themselves, it has an area of 50,000 square feet, or 8333 square feet per furnace. The tapping side is 13in. lower than the charging side. The width of the tapping side is 11ft.

clear from the furnace binders. The floor plates are ½in. thick, and the stage is designed for a load of 3 cwt. per square foot. The staging itself is kept entirely clear of the furnaces, so that each of the furnaces may expand independently, and the stage plates are divided at each furnace to allow them to expand or contract at will.

The chequer chambers are entirely clear of the furnace bath, so as to facilitate the removal of slag, and the removal of material in the event of a break-out, and possess other obvious advantages. Each furnace has five doors on the charging side and two on the tapping side, and the basic furnaces have auxiliary slagging spouts. The doors are hand-operated, and the charging stage immediately in front of the furnaces is made of channels lined with fire-bricks. Indicators, which are placed at the back of the stage, show the direction of the incoming air and gas, the chimney draught, and the pressure in the gas mains. At the back of the stage is a continuous gantry over which the crane in the stock-yard bay can run, and on to this gantry the standard 2-ton charging boxes are placed in a loaded condition. The overhead chargers take these boxes direct from the gantry and empty them into the furnace. Under the centre of the charging stage is a store for dolomite and a mill for grinding it. The ground dolomite is raised by a motor-driven elevator into a dust-proof container at the furnace level.

producer has a revolving bottom and an automatic feed for the coal. The ashes are automatically ejected into side-tipping bogies, which in turn place them in a ground ash bunker, which is situated, together with the coal bunker, about midway in the length of the producer house. The producer building is 256ft. long, with 15ft. 3in. centres of roof shafts, 49ft. 10in. height of eaves, and it is equipped with two 4-ton "Royce" overhead travelling grab bucket cranes, which take the coal from the ground bunker and deposit it into overhead coal bunkers. The latter are each of 15 tons capacity, and one is placed over each producer. The same grab cranes take the ashes from the ground bunker and place them in an overhead bunker, from which they gravitate through a controlled opening into railway wagons below. The whole of the motions of the plant are electrically operated. The gas from each producer is conducted by a downtake into one main gas culvert, from which branches are taken off to each of the six furnaces. The capacity of the ground coal bunker is 370 tons, and that of the ash bunker 54 tons. The overhead ash hopper holds 12 tons.

About half of the service bay is used for general service in connection with the melting plant, such as the making of stoppers, storage of ladle bricks, &c. &c. The remaining portion of the bay is devoted to the slicing of tire ingots, which are cut into six to eight pieces according to necessity, but not

works, duplicate hydraulic pumps for operating the furnace valves, a traffic office for dealing with the whole of the yard traffic, and a fully equipped ambulance room, in which a trained nurse is at all times on duty. On the upper floor is a fully equipped laboratory for the analysis of samples. The staff offices, lavatories, &c., are also on this floor, which is on a level with the furnace stage, the whole arrangement being designed to render the control and management of the furnaces as easy as possible. Ample siding accommodation is provided, and it may be noted that round the whole of the works there are two complete railway tracks, which are independent of such siding accommodation as is used for storage and service.

### TIRE DEPARTMENT.

The tire department, of which illustrations are given in our line Supplement, is situated 400ft. to the north-west of the melting shops, where the ingots from which the tires are made are produced. The main buildings consist of three bays as follows:—Main bay, 561ft. long centres of end columns, 95ft. 9in. wide, 52ft. 6in. floor to eaves. The roof is of the cantilever type in twelve bays running across the shop, the principals being supported by a braced girder 12ft. deep under each of the ridges. These braced girders are also used to support the two inner rails of two light overhead crane tracks, the cranes on each of which span practically

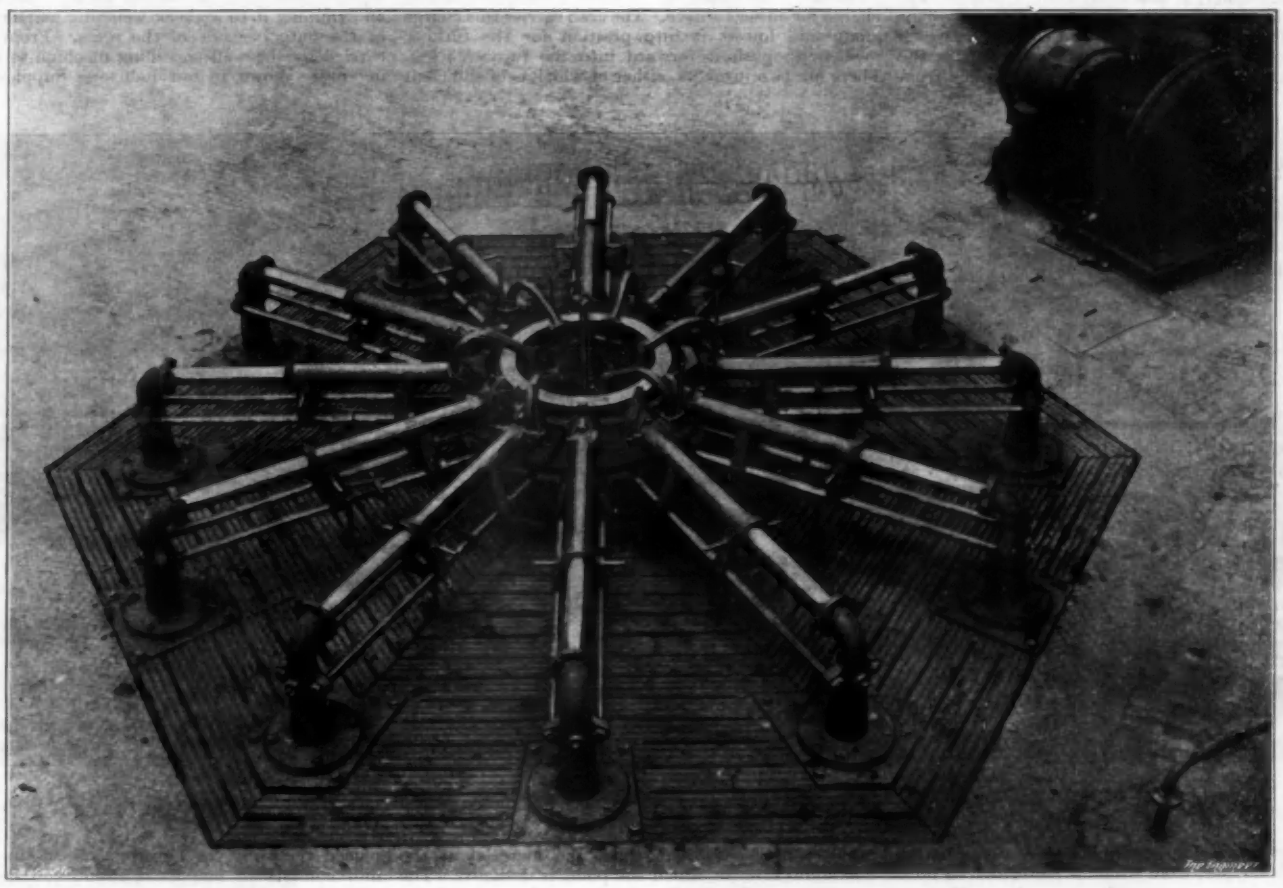


FIG. 2—SANDBERG MACHINE FOR THE SORBITIC TREATMENT OF TIRES

In the casting bay there are two rail tracks, that nearest the furnace being used exclusively for the removal of slag, while the other is for the removal of hot ingots on special bogie cars, which convey them direct to the soaking pits on the old side of the works.

The furnaces are tapped direct into 75-ton steel ladles having overflow slag spouts over which the slag flows direct into the Dewhurst cast iron slag ladles, which run on the first rail track. These slag ladles are removed by a locomotive, and the contents are tipped direct on the adjacent tipping ground. At the opposite side of the casting shop are two casting platforms, below and in front of which are placed the mould bottoms, on which the moulds are set for casting. The ladles are placed directly over the moulds for casting purposes. Various types of moulds are used, both top and bottom pouring being adopted. Generally, the ingots run from 30 cwt. to 60 cwt. each. They are used exclusively for the production of rails, billets, various sections, &c., and for tires, axles and springs. In the centre of the casting bay, and against the furnace tapping stage, are two gas-fired ladle dryers, the gas being supplied from the main producer plant, which is next described.

The gas plant—see the drawings on page 14—consists of eleven Morgan-Sahlin producers, each 9ft. 6in. diameter inside the brick lining, and 11ft. 4in. diameter inside the shell, the total height of each producer above the foundation being 16ft. 6in. Each

broken. The top and bottom pieces only are broken off, and these are left in the melting department as scrap. The other portion is taken to the tire department.

A few words on the auxiliary equipment of this melting department may be of interest. The raw material is delivered, so far as practicable, direct into the stockyard bay, from which it is charged into the boxes. The surplus is placed on various stocking areas around the shops. In the centre of the length of the stockyard, and at one side, there are six areas 15ft. by 10ft. wide for storing ferro-silicon, spiegel, &c., a motor-driven manganese crusher, and a bin for the crushed material, against the stage, and in this stockyard are two 15-ton weigh-bridges arranged one at about one-third from each end of the shop. These machines can weigh three boxes at a time, the box being handled by special gear on the cranes. The ingots for despatch to the soaking pits are placed in special steel bogies supplied by Dewhurst's Engineering Co., each with a capacity of 30 tons. They carry nine ingots, and each ingot is in a separate pocket to keep it vertical while it is in a semi-molten condition. The slag cars, also by Dewhurst's Engineering Co., have a capacity of 15 tons each, and an approximate weight of 22 tons each.

At the railway end of the melting shops, is situated a block of offices, &c., a brick building consisting, on the ground floor, of a small auxiliary sub-station for the distribution of current to this section of the

half of the shop. At a lower level the whole shop is spanned by one crane. The rail level of the top tracks is 48ft. 5in. above the floor line, and of the lower track 30ft. above the floor. At one side of this main bay there is a machine bay, of similar construction, but half the length. Its width is 68ft. 7½in. and it has one crane track of 56ft. span, 44ft. 6in. above floor line. At the other side of the main bay is a service bay. The roof span is 32ft. and the height from floor to eaves 25ft. 6in. The crane track runs the whole length of this bay at a span of 30ft. The length of the bay is 561ft. At each side of the service bay are wing bays, each 12ft. wide, giving a total width for the service bay of 56ft.

The whole of the buildings are of structural steel, supplied and erected by Sir Wm. Arrol and Co., Limited, of Glasgow. They are provided with ventilation by continuous lanterns on each ridge, and the outer walls are covered entirely by corrugated asbestos sheeting. The roofs are glazed throughout with ¼in. rough-cast glass on tee astragals.

The floor of that portion of the main bay on which hot tires are placed is covered with fire-bricks laid on edge. The whole of the remainder of the floor is covered with 2in. cast iron floor plates laid on ground slag filling. The machine bay floor is covered with 2in. cast iron plates, while the service bay has its floor finished partly in concrete and partly in tar-macadam.

The crane equipment is as follows:—Main bay: One 25-ton "Arrol" three-motor overhead electric

travelling crane, span 90ft., height from floor to crane rail 30ft., main hoist 10ft. per minute, auxiliary hoist 6½ tons, 30ft. per minute, traverse 120ft. per minute, travel 300ft. per minute; and four 2-ton "Wellman" electric overhead travelling underhung jib cranes, two running down each half of the shop, span 42ft. 3½in., crane rail 48ft. 3in. above floor, radius of jibs 13ft., hoist 75ft. per minute, traverse 150ft. per minute, slewing 3 revolutions per minute, travelling 500ft. per minute. The machine bay contains two "Arrol" 5-ton electric overhead travelling cranes, span 56ft., floor to crane rail 44ft., hoist 50ft. per minute, traverse 120ft. per minute, travel 400ft. per minute; while in the service bay there are two 2-ton overhead travelling cranes, span 30ft., floor to crane rail 20ft.

The service bay is divided for the various purposes. At the south-west end is the pump-house, containing two "Davy" motor-driven hydraulic pumps having a capacity of 83 gals. per minute each against a pressure of 1500 lb. per square inch, two "Mather and Platt" rotary motor-driven boiler feed pumps, and one "Alley and Maclellan" motor-driven air compressor.

Next to the pump-house are three "Wellman" gas producers, and adjoining these are three 30ft. by 9ft. Lancashire boilers fitted with mechanical stokers and coal-handling gear. The coal is delivered to the plant immediately adjoining the gas producers. It is discharged from bottom-opening wagons into a ground coal bunker, in which is a worm which conveys it to a feeder hopper at the foot of an elevator. This elevator lifts the coal into overhead conveyors, which feed it into hoppers over either the producers or the boiler fronts as may be required. The ashes from both boilers and producers are dumped into an underground ash hopper, from which a motor-driven hoist takes them into an overhead bunker, whence they are delivered, through a controlled opening, into a standing wagon. Next to the boilers is situated the general stores for the whole of the Penistone Works, being a sub-stores of the main stores department at Sheffield. The size of the store is approximately 92ft. long by 56ft. wide. Adjoining the stores is a tire roll store, 70ft. long by 56ft. wide. Next follows a space 92ft. long by 56ft. wide, which is used for the preparation of test pieces, the turning of tire rolls, and small minor repairs in connection with the tire plant.

The remainder of the service bay consists of a space 140ft. long by 56ft. wide. It is used for the storage of tires which await inspection, and also contains the general offices serving this department. The offices consist of a brick building 128ft. long by 14ft. wide. There is an office for the use of inspectors, a test room equipped with a motor-driven 50-ton "Avery" tensile testing machine, offices for clerks, managers and foremen, and staff lavatories. The three bays of this department are connected by an electrically operated bogie, taking its current from a conduit below.

The sliced ingots arrive at the tire department at the furnace end, as indicated above, and the finished tires are despatched from the opposite end directly on to the London and North-Eastern Railway. Outside this despatch end of the shop are placed tups for the testing of tires by means of a 1-ton falling weight. There is also a "ringing" machine, from which tires are dropped on to a metal plate. The main plant is placed in line on the south-east side of the main bay, and consists principally of plant for breaking sliced ingots, two continuous gas-fired furnaces for heating the slices; one 2500 tons hydraulic press; one horizontal tire roughing mill; two horizontal finishing mills—see the half-tone supplements—one 500 tons hydraulic marking press, together with auxiliary gear, such as weighing machines, handling machines, &c.

The sliced and unbroken ingots, minus the top and bottom scrapped portions, are delivered on special 70-ton bogies direct into the south-west end of the main bay. They are unloaded by a 25-ton overhead crane and stacked for stock at the left of the rail track or for direct use on a raised platform at the charging end of the furnace. A hydraulic pusher is placed on the centre of this platform and has accommodation in front of its head for five or six ingots. By its means the ingots are pushed one at a time on to a narrow guide track, which ensures them being immediately under the centre of lift of the charging apparatus, which is supported overhead on a steel structure. This charging apparatus consists of a small electrically operated travelling crab supporting a special lifting magnet and an automatic breaking tup. The breaking tup consists of a cylinder in which is fitted a special patented apparatus for automatically gripping, raising and releasing a circular tup. Steel wedges are placed in the sliced openings in the ingots, and on to these wedges the tup is dropped, so that the pieces are readily separated in one or two blows. The length of the magnet is equal to the width of the furnace, and by this means sufficient of the broken "cheeses" are lifted up to form a complete line of charge for either furnace. The crab carries this charge along and lowers it into position for the furnace pushers to push it forward into the furnace itself. There are two furnaces, either of which is of sufficient capacity satisfactorily to heat the material at the maximum rate for which the plant is designed. The furnaces are therefore used alternately and thereby kept in the best possible condition. Each furnace has an overall length of 68ft. The bed, which is composed of bull-head rails in short lengths, has a length of 50ft. and an incline of 1 in 14, while the length of the hearth on to which the blooms drop is 8ft. The width of the furnace is 6ft. 6in.

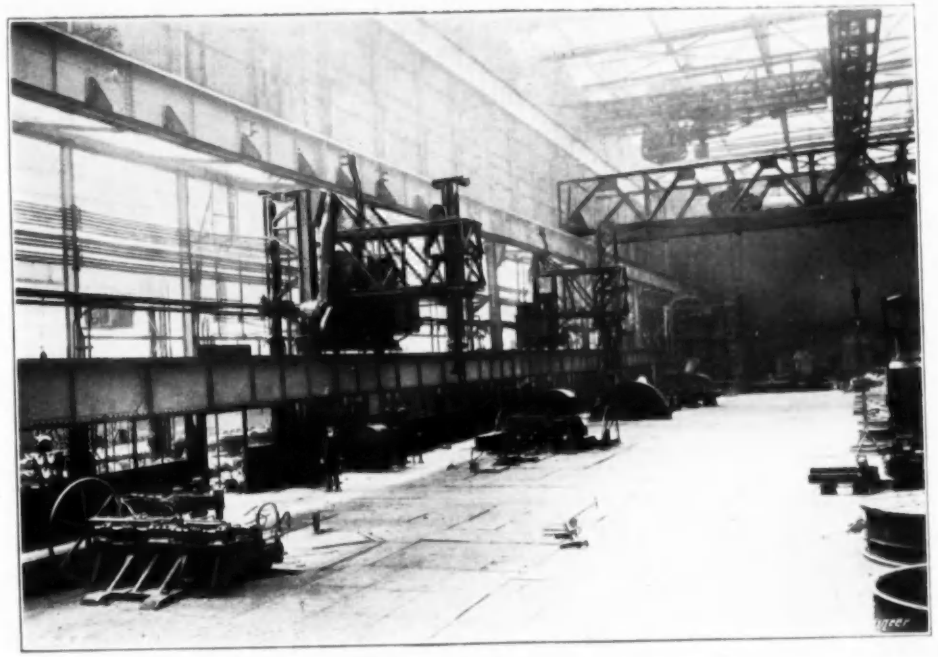
Gas is supplied to the furnaces direct from three 10ft. "Wellman" producers, situated immediately at their side, and in the service bay. Two of these producers are ample for ordinary requirements, and the third is a spare. The slice is removed from the furnace by means of a "Wellman" floor charger, which runs on a track situated between the two furnaces and is placed on an automatic weighing machine, which was supplied by Henry Pooley and Son, Limited, and was specially designed to the company's requirements. The machine does not indicate the actual weight of the slice, but the excess over a net calculated weight to which the machine is set, thereby showing the press operator on a dial the amount he has to punch out of the slice to give the exact net weight required for the tire. Two pointers are provided on the weighing machine, both of which register the excess weight when the slice is on the machine; but when the slice is removed from the machine, the weighing pointer returns to zero, while the other stays in position until the next slice is put on to the machine. The slice is next taken by the charger and placed on the first or slabbing anvil of the forging press, this being moved hydraulically into position under the centre of the press. The press is provided with hydraulically operated centring fingers or manipulators, which immediately centre the slice on the anvil. The former is flattened by the main tool of the press, and is then raised by the manipulators. A bottom punch, which rotates on one of the press columns, is brought exactly under the centre of the bloom, and the bloom is pressed on to it, with the result that a hole of the required depth is formed. The manipulators again lift the bloom, the bottom punch swings out of position, and the table slides to bring the second anvil or die plate under the centre of the press. The bloom is then lowered on to this second anvil or into a die, and the top punch, which rotates on another of the press columns, is then brought into position. The press then, by means of the top punch, completely punches out the thickness which was left by the bottom punch, and this punching drops straight through the anvil, and on the next sliding movement of the table is projected through a hole in the press base into a skip. The main tool of the press is now brought on the pierced slice, which is thereby flattened to final dimensions, and is at the same time compressed into a tapered die which forms a circular periphery. The slice is then ready to leave the press as a finished bloom. By this time another slice has been placed upon the first anvil, and the table slides forward, bringing this new slice under the press, and at the same moment placing the already finished bloom in a suitable position for removal. The pierced bloom is first raised by four ejector rods, which lift it some inches clear of the anvil. A specially designed jib crane running on a wall track now places a peel underneath the bloom, lifting it off the fingers and running it to a check weighing machine situated at the outgoing side of the press. From here it is carried by the wall travelling machine to the roughing mill—shown in our half-tone Supplement—and

FIG. 3—BATTERY OF RICHARDS TYPE BORING MILLS

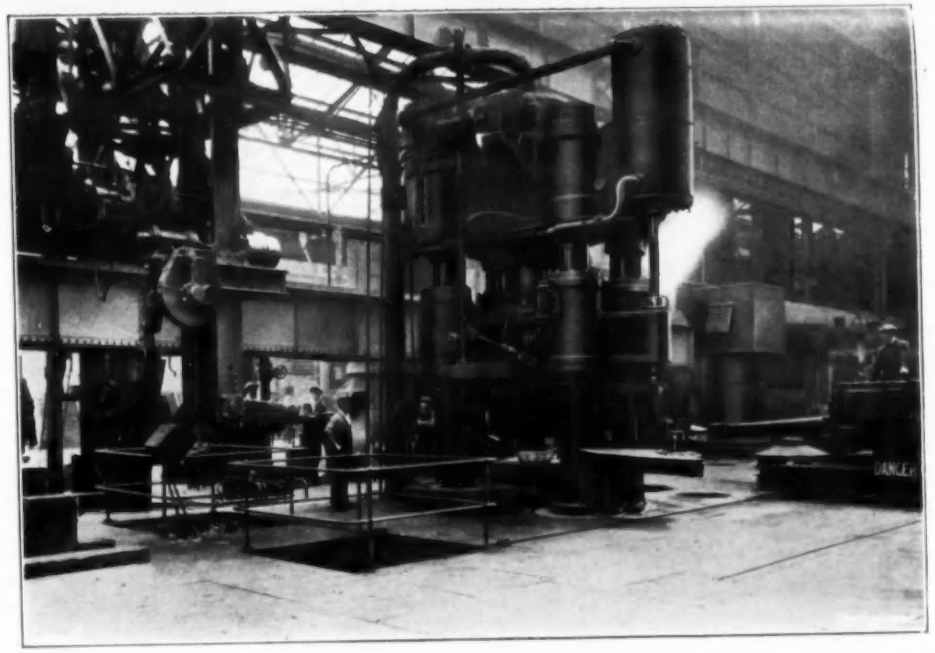
placed vertically on the inside roll of the mill. The mill consists of one fixed inside roll driven by a variable speed motor, and one outside roll carried in a rising and falling carriage balanced by rope gear to give parallel motion. The outside roll is raised by hydraulic pressure, and the tire is quickly brought into an approximation of its ultimate section. A second special wall jib crane now takes this roughed tire and runs it to one or other of the two finishing mills, which are of the ordinary horizontal type, electrically driven. Full particulars of the electrical drives and all other electrical equipment in the works are described later.

The tire is now taken by one of the overhead jib cranes and placed on the marking press, where the whole of the marking is done at one stroke. On this press is fixed a special pyrometer, by which the finishing temperature of every tire is taken and recorded for future reference. Close to the marking press are two oil tanks for treatment purposes; also one oil-fired furnace for the heat treatment of such tires as have particularly severe specification tests.

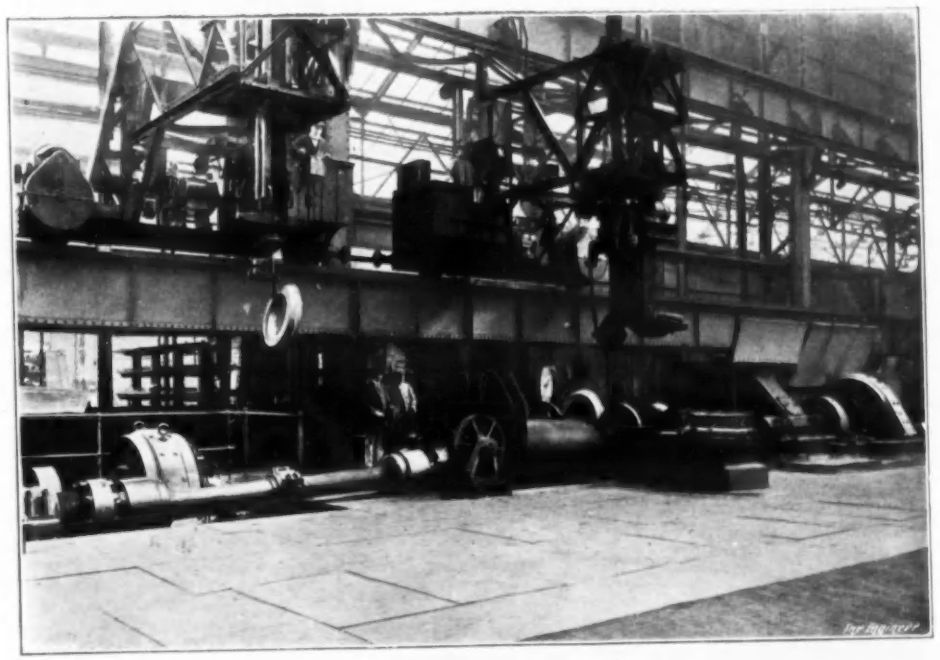
The remainder of the equipment of this bay consists of machines for weighing, straightening, rounding, &c., and an interesting appliance recently installed is a machine for the sorbitic treatment of tires by the Sandberg process. The machine is illustrated in Fig. 2. It was designed by Cammell Laird and Co., and made in their own workshops to conform to the process of Mr. C. P. Sandberg. It consists of twelve external heads delivering a mixture of air and water on to a rotating tire. It is electrically driven, and all its motions are automatically operated, thereby eliminating a possibility of error in treatment, due to carelessness or other causes. An interesting feature in the disposition of the main plant is that the furnaces, press and all mills have their centres in one



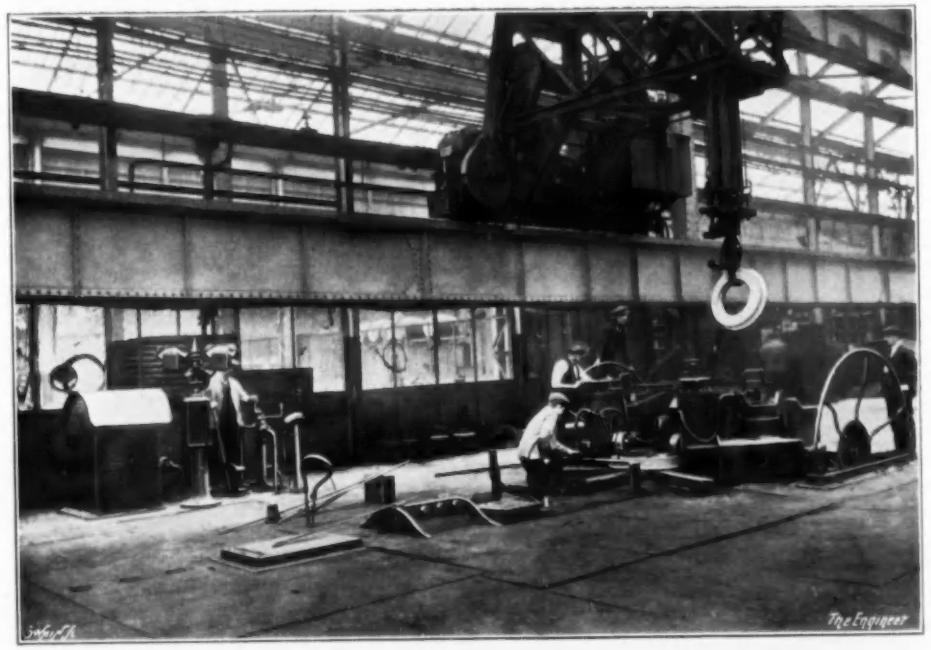
GENERAL VIEW OF TIRE SHOP



DAVY BROS. STEAM-HYDRAULIC TIRE PRESS

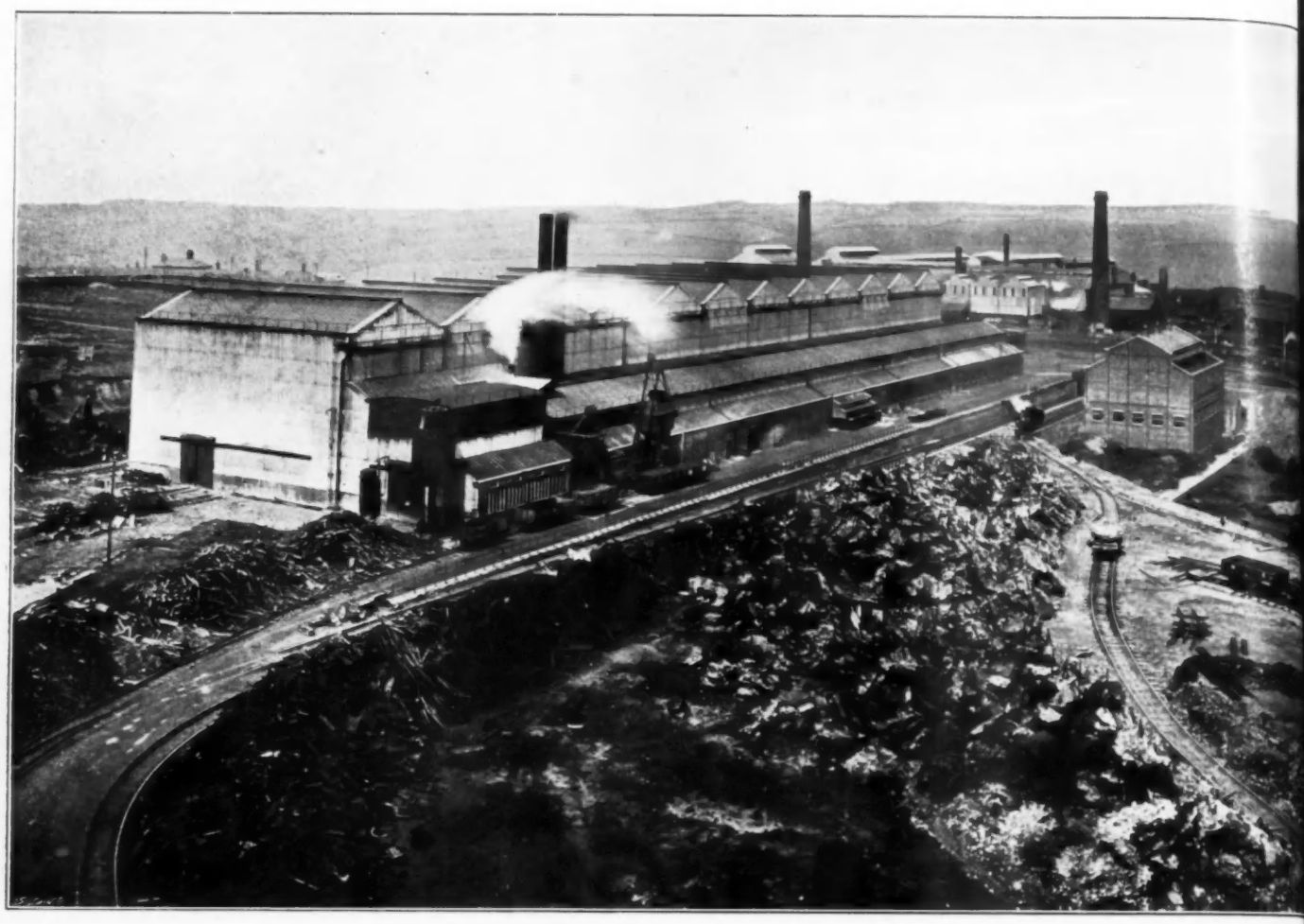


TIRE ROUGHING MILL



TIRE FINISHING MILL

# THE PENISTONE WORKS OF CAMMELL



GENERAL VIEW OF THE

STRIPPING CRANE IN STEEL MELTING SHOP

WALL PEEL CRANE IN

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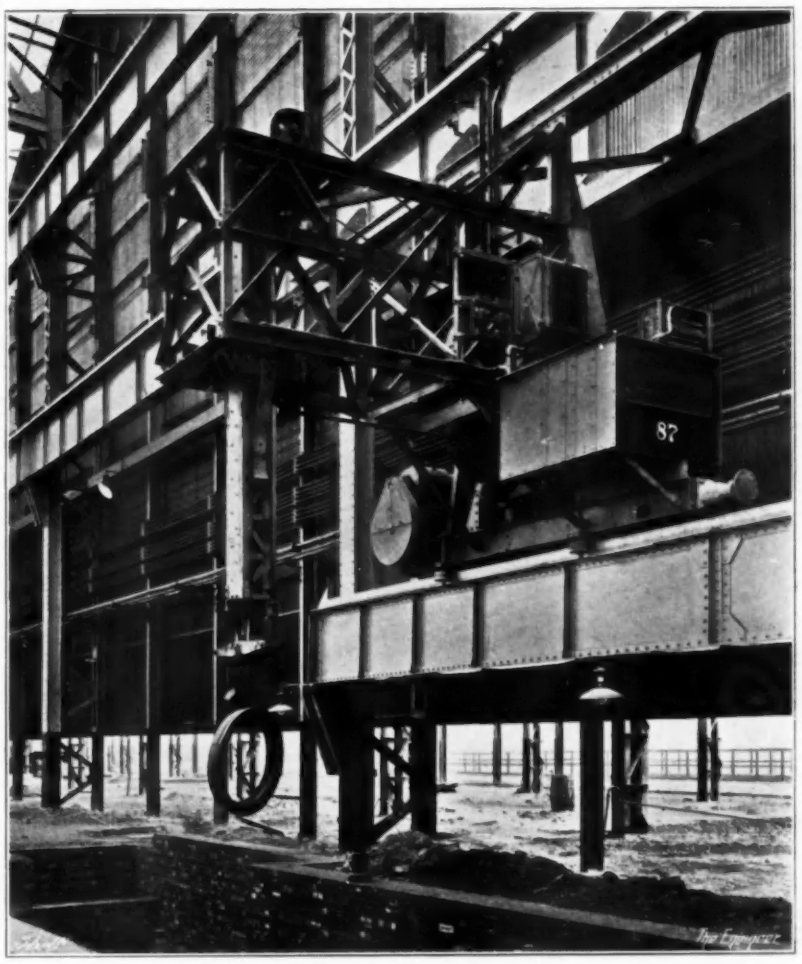



WALL HOOK CRANE IN TIRE SHOP

# THE PENISTONE WORKS OF CAMMELL LAIRD AND COMPANY, LIMITED

STEEL FURNACES—CHARGING SIDE

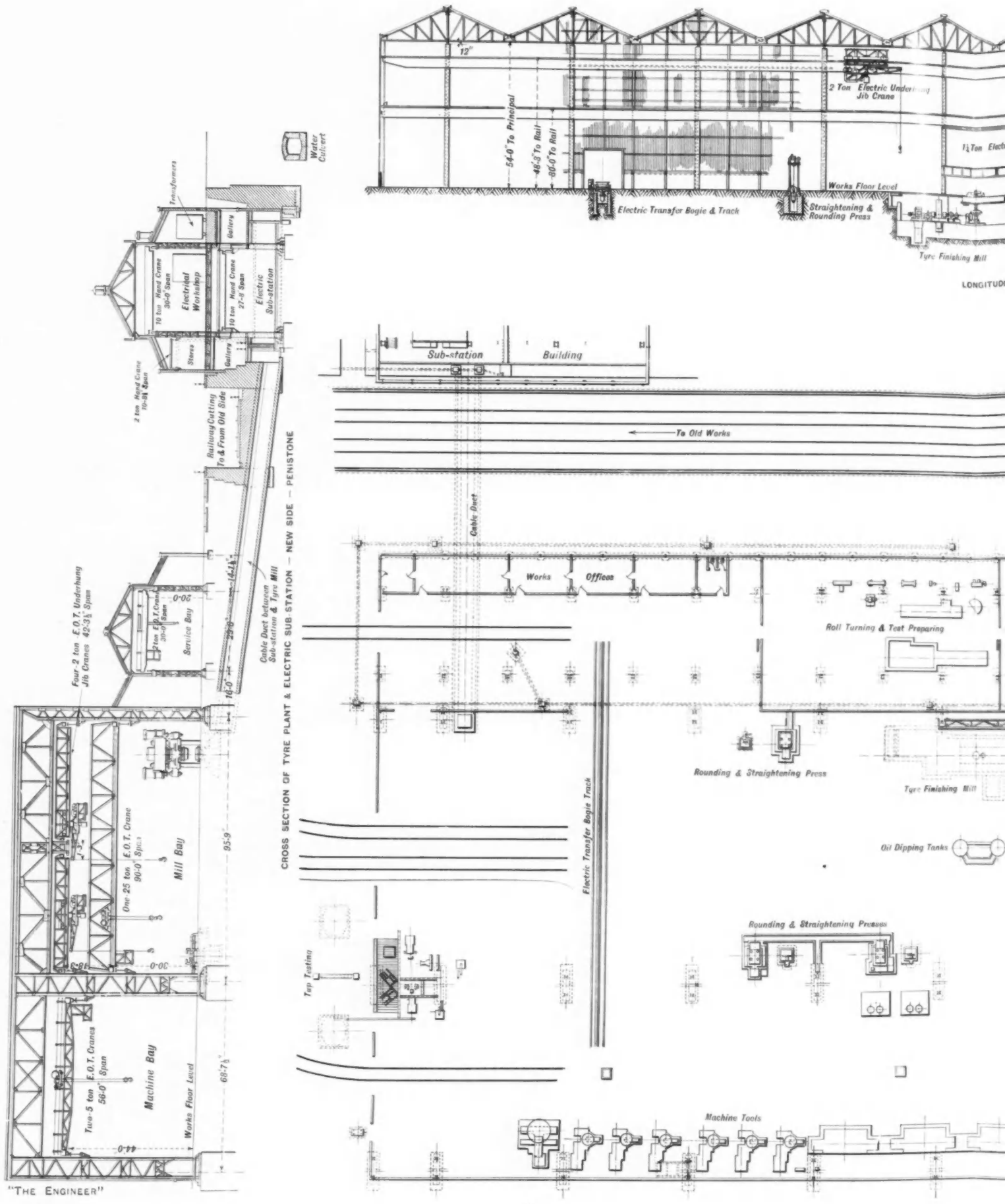
STEEL FURNACES—TAPPING SIDE

FURNACE CHARGER

OVERHEAD FURNACE CHARGER IN STEEL MELTING SHOP

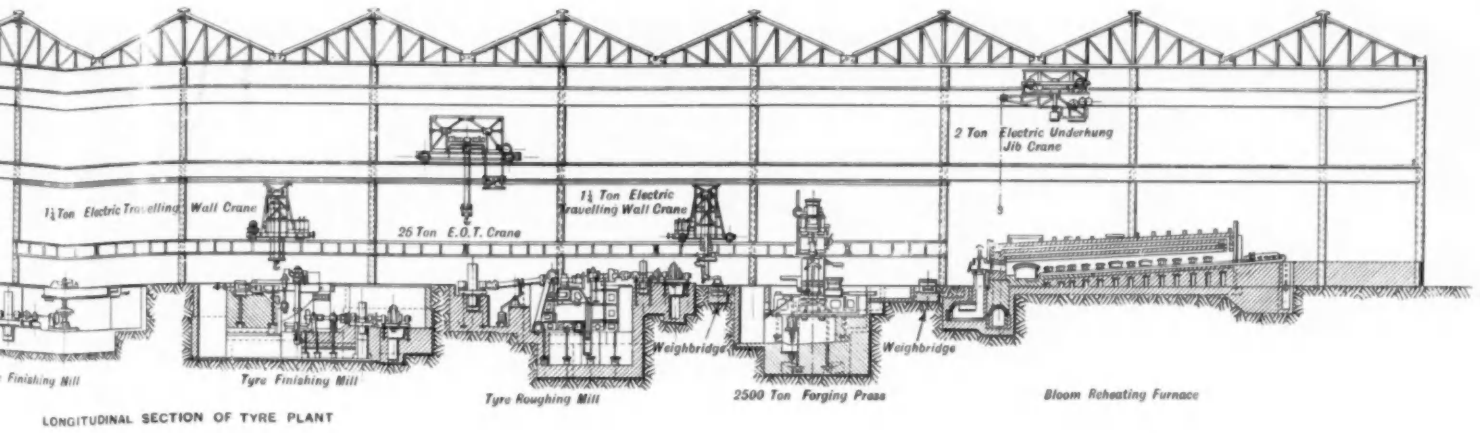
FURNACE CHARGER

# THE PENISTONE WORKS OF CAMMELL LAIRD AND CO., LIMI

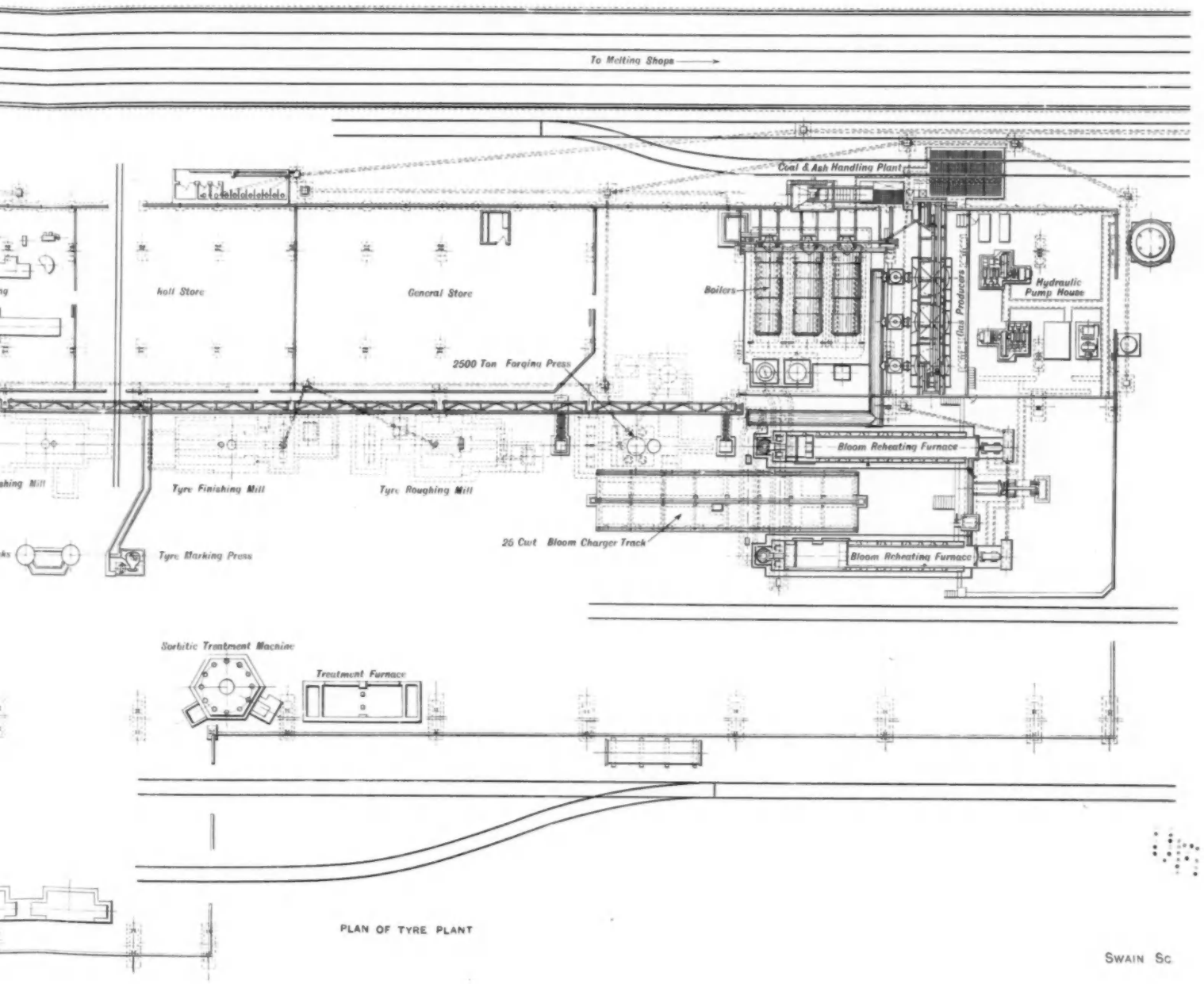



"THE ENGINEER"

# ..., LIMITED—PLAN AND SECTIONS OF TYRE PLANT BUILDINGS




LONGITUDINAL SECTION OF TYRE PLANT




PLAN OF TYRE PLANT

SWAIN Sc

continuous straight line, thereby eliminating all cross motions and simplifying the movement of the piece through its various operations.

Only a portion of the tires are machined, and the work is done in the short bay—Fig. 3—adjoining. For this purpose the plant consists of six "Richards" 60in. boring and turning mills, one "Buckton" 8ft. boring and turning mill, two 40in. "Duplex" Webster and Bennett boring and turning mills, and three double face plate wheel lathes.

## International Air Congress.

No. II.*

WHEN the delegates attending the International Air Congress reassembled on the morning of June 27th, the section which met under the chairmanship of Lieut.-Colonel M. O'Gorman had before it the paper by Mr. J. D. North, "The Technical Development of the Aeroplane," of which the following is an abstract.

### "THE TECHNICAL DEVELOPMENT OF THE AEROPLANE."

By J. D. NORTH.

Mechanical flight in the brief twenty years of its existence has passed through four phases, each of an approximately equal period, and which are defined sufficiently clearly to be marked by the observer. There are indications that we are now entering on a fifth phase in the art and practice of aviation, the trend of which forms a legitimate field for speculation.

Let us take stock of our technical assets. We have a large amount of incompleted work which requires sifting and developing to its proper conclusion. We cannot expect to develop the aeroplane on the heroic lines, the achievement-at-any-price methods, which were proper to the war period. Probably we shall be compelled to concern ourselves mostly with small matters out of the multitude of which great things may come. First, there is the development of the aeroplane from the economic standpoint, the improvement of the ratio of the useful load to the gross weight, and the improvement of fineness whereby for given horse-power this gross weight may be given a better performance. These may be attacked either by systematic improvement of detail or more speculatively by radical changes in design. The scope for advance on existing lines may be summarised as follows:—

*Reduction of Structure Weight: (a) A More Accurate Knowledge of External Forces in Flight.*—As our knowledge of the external forces of an aeroplane in flight are extremely limited for purposes of design, we are obliged to use purely conventional assumptions. It is clear that with a more accurate understanding of the actual forces which have to be met a lighter structure could be produced with the same degree of reliability.

(*b*) *More Reliable Methods of Stress Computation.*—This will enable us to use our materials more economically.

(*c*) *Improvements in Structural Arrangement.*—In this direction there does not seem to be a very great scope for progress, except by radical changes of design involving redistribution of the principal weights.

(*d*) *Specifically Stronger Materials.*—Here we have already made a very notable progress in the substitution for timber of steels and alloys for aluminium, and generally in the use of better quality steels. Further substantial advances in this direction are to be expected.

(*e*) *Reduction in Overall Dimensions.*—The extent to which this is possible is bound up with questions of aerodynamic design which are considered later.

*Reduction in Weight of the Engine and the Fuel Consumption for a Given Power.*—There do not appear to be great prospects of immediate improvement in engine weight or consumption. The most effective results may be expected from the use of suitable supercharging devices for increasing performance and altitude. Such devices are vitally necessary for military aeroplanes and have been used successfully in the experimental stages. So far as fuel consumption is concerned, where very long journeys are involved there is quite a possibility of re-fueling in flight. It has repeatedly been shown that aeroplanes can establish contact with one another in the air, and should it become necessary in the future, large civil aeroplanes might be re-fuelled by tankers from stations at suitable short intervals of two to three hundred miles.

*Reduction in Dead Weight.*—That is to say, the weight of the crew and their necessary instruments, &c., in relation to the useful load. At the present time this figure is very high on commercial aeroplanes.

*Aerodynamic Improvement.*—In considering the performance for a given power load it is necessary to decide what class of performance is required—rapid transport or power of quick manœuvre. Military aeroplanes may broadly be classified as:—(1) Aircraft for offensive action against aircraft; (2) reconnaissance machines capable of self-defence; (3) bombing machines capable of self-defence; (4) bombing and transport machines practically incapable of self-defence.

The first class will depend for its power of offence on manœuvrability, speed and climb, which enable it to bring its armament effectively into action. The necessity for these qualities diminishes gradually from class to class till with the fourth class the conditions are much the same as those required for civil aeroplanes. In the machines which are intended for transport purposes the surface loading is practically controlled by the necessity of rising from and landing on certain types of grounds under reasonably safe conditions. There may, however, in the future be this important distinction between military and civil aircraft, at any rate when the latter are used in civilised countries, that whereas military aeroplanes may be required to land and rise from unprepared ground, it may be that in future air lines will run over a series of flying grounds so arranged as to make possible with safety, landings at a speed which could not be thought of in ordinary cross-country flying as we now understand it. It is in connection with these transport machines that such devices for increasing lift as the slotted wing and the variable trailing flap should prove most useful.

*Head Resistance.*—The outstanding item of head resistance which should be reduced is the very large proportion arising from the existing arrangements for cooling the engine, as it is not uncommon for this to represent 20 per cent. of the total resistance of the machine. Improvements are to be expected by increasing the temperature difference between the cooling medium and the atmosphere (*e.g.*, steam cooling) and by the use of aerofoil or similar surfaces as radiators (*e.g.*, tubes arranged round the aerofoil or body surface and conforming to the profile thereof). In the case of air-cooled engines it is necessary to provide a properly controlled and relatively low-speed air flow if the resistance is to be kept down. As the drag increases in proportion to the second power of velocity and the dissipated heat as rather less than the first power, the importance of large cooling surfaces with comparatively low velocity air currents will be appreciated. It is unfortunate, of course, that to fulfil such requirements an increase of weight is to be feared and we shall have to strike a balance between the two conditions.

It has on more than one occasion been pointed out that the maximum lift drag of an aeroplane is very much worse than that of a good streamline form. This is due to the additions of engine cooling, resistance, drag from stabilising and control surfaces, undercarriage, external wing structure, and the departures from the streamline form of body which are necessary to give adequate view and accommodation to the occupants or to provide a good field of gunfire. In the case of that class of military aeroplane which must fly over any country and must depend on its power of manœuvrability for offensive and defensive action it is very probable that a nearer approach to the ideal can be obtained; but in the case of transport machines it seems quite likely that considerable refinements can be carried out somewhat on the lines suggested by Professor Junkers many years ago, namely, to provide all necessary accommodation inside the wing structure and to make that structure complete without external bracing. A little arithmetic will show that to realise these ideas, *i.e.*, wings deep enough for head room, the aeroplane must have a gross weight of about 15 tons, and it would only be possible to construct internally braced planes economically on an aeroplane of such a size by distributing the whole of the load along the span of the wing. This is by no means impracticable, and although it would have the effect of giving the aeroplane a very slow rolling and yawing period, it would not make the machine at all uncontrollable so far as straightforward flying is concerned.

*Reliability and Safety.*—The safety of an aeroplane depends primarily on its ability to keep itself in the air and to be under control when landing. Increased insurance against forced landings from engine failure can be obtained by a plurality of power plants, provided the aeroplane is capable of flying with suitable fractions of its total power. It seems likely that only the higher-powered military aeroplanes can use the two-engine arrangement with advantage, since only with such machines is it possible to provide at least twice the necessary minimum power for flight, while the three-engined aeroplane seems to be indicated for immediate transport needs.

Lack of control near the stalling speed is still apparently one of the most frequent causes of accidents, and the systematic investigation of this problem which is being undertaken in this country seems to hold out hopes of getting over this trouble. Control for the purpose of rapid manœuvre is, however, largely dependant on the overall dimensions of the machine. There is one point in this direction which is often overlooked. Effective manœuvre depends on the time which elapses between the event taking place which necessitates the manœuvre and its completion. The time necessary for the pilot to respond to the stimulus of the event is governed very largely by the comfort and convenience with which he can see what is going on. This actually has an important effect, and a favourable situation of the pilot in the manner possible on twin-engined aeroplanes greatly increases the real power of manœuvre.

*Conclusion.*—It is very obvious that there is no difficulty in finding technical work to do. Those difficulties which are confronting the development of the aeroplane can be attacked systematically apart from the question of general research. The new small aeroplanes which have recently been successfully flown seem to me to offer a most promising field for obtaining full-scale results, enabling large aeroplanes to be flown in what is practically model form. If this is possible it should help considerably to accelerate our progress, for the aeroplane must be developed on the experimental flying field far more than it is at present, and at least as much as in the laboratory or the drawing-office.

Captain F. M. Green expressed his general agreement with the author. It was obvious, he said, that more experimental work of an actual flying character was required, but private firms found it very difficult to justify expenditure in carrying out an investigation on those lines. He would suggest, however, that the time at present allowed for test flights when carrying out Government contracts might be extended. This would be one way in which to surmount what was realised to be an obstacle to progress.

Colonel Heckstall Smith said that although various reasons were given for failures which occurred in the performances of aircraft, most of the shortcomings which came to light were probably due to defects in the materials employed. Trouble was experienced during the war period with unsound steel, but the difficulty was overcome. It was very necessary, to-day, that more study should be devoted to ascertaining the causes of defects and to see how far they were caused by design and how far they were due to defective material.

Mr. R. A. Bruce commented on the use which could be made for experimental purposes of the small aeroplane. It would be a good thing if, in every case of a new design, a small flying model was also constructed for experimental work. The ability to carry out tests on the smaller machine which would predict the performance of the larger machine would be associated with a good deal of economy. It could not be disputed that some of the more serious problems of flight could be tackled in this way to the great advantage of designers.

Major J. S. Buchanan referred to the large amount of undigested technical information on the subject of aeroplane design which was already available, and which had not been applied to the machines which were being constructed at the present time. A very controversial question was the single engine *versus* the twin-engined machine. In his opinion, for ordinary purposes, the value of single and twin-engine installations was the same, because in practice when one of the two engines failed it was the habit of the pilot to look round for the nearest landing place. It was difficult to see how, in a small machine, it was possible to reproduce the qualities which were required in a large machine, and he could not agree that that had been done.

Mr. Handley Page said that the essential requirement in the technical development of the aeroplane was to concentrate attention on those parts of the machine from which a definite performance was expected, and not to fritter the energies of research workers away by causing them to pay attention to mere auxiliary questions which had no real relation to the actual merits of the design. If the test of relation between weight and horse-power were applied to the existing types of machine, he doubted whether much real progress had been made since the end of the war, the apparently improved performances now obtained being due either to the installation of larger engines or to other expedients which did not represent a real advance. The question of the relative reliability of single and twin-engined machines had been raised. At one time he would have stated with the complete confidence of perfect ignorance that the twin engine made for safety. It was necessary to modify that view, having regard to the increased reliability of single engine machines, although it could not be overlooked that in the event of failure of one of two engines the remaining engine could be utilised to get the machine back to the aerodrome. With a single engine, in case of failure, the machine would have to land where it could, which meant trouble and delay in effecting the necessary repairs, and the machine was out of service for a longer period than if by the use of the reserve engine it had been able to return to the aerodrome. Mr. North had referred to the question of cooling. In some American machines the practice was followed of eliminating the radiator and utilising the surface of the wings as a radiator. He understood that that type of design had found favour with the United States Government for all purposes, although it seemed to him that it exposed a greater area of machine to attack in military aircraft. The suggestions made by Mr. North as to the lines of improvement in design were most interesting, particularly the possible increase of weight per horse-power while maintaining the getting-off capacity.

Commander E. S. Land said that with the American type of wing radiator a certain amount of perforation could be withstood without serious damage to the fighting qualities of the machine. One point he would like to emphasise was the need for more co-operation between those who operated machines and those who built them. It would be of immense advantage to designers if pilots could be induced to put their experiences in writing, although he for his part was unable to suggest how the average pilot could be persuaded to give a written account of any difficulties he experienced.

Mr. Plesman said it would be impossible to persuade pilots to put anything in writing, but since the need for linking up the flying ground with the research department and laboratory was obvious, he would suggest that a representative of the research side should visit the aerodrome and bring about liaison with pilots. Pilots would talk but they would not write.

Mr. Kennedy asked a question about the Junkers design to which Mr. North had referred in the paper, in which an attempt was made to provide all necessary accommodaton inside the wing structure and to make that structure complete without external bracing.

Lieut.-Colonel O'Gorman said, in connection with the relative merits of single and twin engines, that statistics viewed in a broad sense showed that as regards accidents the single engine machine was to be preferred. He agreed that there was a want of co-operation between operators and constructors. The opinions of pilots would be valuable on many points. Their experience was needed, for example, to decide such a point as whether to gain speed a greater degree of vulnerability could be accepted. It seemed to him that speed, vulnerability and freedom from accidents could be got down to a common denominator, but the figure had not yet been found. He appealed to pilots to be more communicative and give their help to designers so that improved types of machines might be evolved.

Mr. North agreed that the question of the small aeroplane was an important one, but it ought to be made clear that the difficulty which confronted constructors in Great Britain was that they were engaged in carrying out contracts to provide machines for specific performances, and it was not easy for them to make experiments or to test technical theories. Their main work was to provide a satisfactory vehicle for public service and not to build experimental machines to test theories at their own expense. He agreed that it was possible with a small machine to obtain valuable information which might be embodied in the design of a large machine with confidence. It had been suggested that failures, particularly in the case of engines, were almost entirely of a metallurgical character, and on that subject he would point out that very little was yet known on the subject of the fatigue of materials used in aeroplane construction. Mr. Handley Page questioned whether real progress was being made, but, as he had already indicated, the development of new ideas meant the carrying out of a tremendous amount of experimental work and the taking of considerable risks, and the present state of the industry would not justify the outlay of time and money. The only way of tackling some of the problems which had come up for solution was to build special machines for the work, and if this were done, he had confidence that it would be possible to develop new and useful designs. With regard to the question of weight per horse-power being increased, he believed that Mr. Handley Page's answer to the conundrum was the use of the slotted wing, but that was not the only answer, and he had great hopes that an artificial means of getting an aeroplane of comparatively low power off the ground might be devised. On the subject of reliability and the employment of twin and multi engines, the real difficulty was that if an aeroplane were given the qualities to assure absolute reliability, the machine

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would be over engined. Lieut.-Colonel O'Gorman had referred to the question of statistics and the light they threw on the use of single and twin engines. His own view was that there were nothing like enough data available on the subject to enable any sound deductions to be made. A question had been asked about the Junker design, and he could only say that the details could be obtained from the patent specification. In spite of what had been said by Mr. Plesman, he still believed that an effort should be made by pilots to put their experiences into writing, as the mere fact of making a written record led to that accuracy of statement which was likely to be of real use to designers.

Another section, meeting under the chairmanship of Brig.-General R. K. Bagnall-Wild, discussed a group of three papers. The first, by Wing-Commander Hynes, was "A Survey of Recent Work carried out in the Research and Experimental Department of the R.A.E."; the second, a paper by Mr. A. E. L. Chorlton, "The Crude Oil Aero-Engine," and the third by Mr. A. H. R. Fedden, "Some Problems of Static Radial Air-cooled Aero-Engines."

In the course of his paper, Wing-Commander Hynes made the following remarks regarding supercharging and flight at high altitudes :—

Two types of supercharger are at present undergoing trials, viz., an exhaust-driven turbo-compressor and a gear-driven blower.

With the exhaust-driven blower a number of flights have been made to approximately 30,000ft., and although the machine, which is a D.H. 9A, has not been specially modified for the purpose, and is therefore not by any means the best possible combination, the absolute ceiling had not been reached at this height.

It is noteworthy that this supercharging unit has given no trouble, and that all the defects experienced have been in connection with auxiliaries and accessories, such as oxygen and breathing apparatus, heated clothing, instruments and fuel pumps, &c.

The defects have been chiefly due to the effects of the extremely low temperatures encountered, —45 deg. Cent. having been recorded on more than one occasion. In this intense cold, for instance, the pumps, although lubricated with a special oil, became erratic in operation, apparently due to partial freezing up. On another occasion the tail gear got frozen up. Instruments have been found to become unreliable, especially if depending in any way on rubber.

The following extracts are taken from Mr. Chorlton's paper :—

The greatest problem in designing a crude oil aero-engine is to conform to some weight factor that is acceptable to the aeroplane designer. The designer of the aeroplane being used to an engine weight of about 2 lb. per brake horse-power, looks upon this as the desirable figure. He longs for less, but how much more will he accept, even with all the advantages of crude oil? It is fairly certain that for planes we may place the figure at 4 lb. per brake horse-power as a maximum; for airships we may possibly go higher. Sir Trevor Dawson, in a paper read at the Air Conference in 1920, gave his possible figure as 10 lb. for airship engines.

Light weight in present aero-engines is obtained only by optimum conditions, *i.e.*, maximum B.M.E.P., coupled with high rotational speed and the use of light alloys. Both high B.M.E.P. and high rotational speed present very great difficulties in the use of crude oil.

The weight of an engine is governed quite materially by its compression pressure and the maximum that it was thought at one time might arise. In the case of the Diesel engine these would be approximately up to three times as high as those which occur in the normal petrol engine.

The main features of four typical engines used for submarines are given in Table I. From this table of basic figures it will be seen that they are far from what aircraft conditions call for; the mean pressure must be higher and the rotational speed greater.

Similar particulars of five modern aeroplane engines are given in Table II.; the difference will at once be seen.

TABLE I.—*Submarine Diesel Engines.*

| B.H.P. | Number of cylinders. | Revs. per min. | Piston speed, ft. per min. | B.M.E.P., lb. per sq. in. | Approx. weight, lb. per B.H.P. |
|---|---|---|---|---|---|
| 1200 | 12 | 380 | 950 | 84 | 58 |
| 1750 | 6 | 380 | 1315 | 85 | 60 |
| 3000 | 10 | 390 | 1350 | 86 | 60 |
| 1500 | 8 | 300 | 1180 | 79 | — |

TABLE II.—*Modern Aeroplane Engines.*

| | | | | | |
|---|---|---|---|---|---|
| 450 | 12 | 2000 | 1710 | 122 | 1.86 |
| 240 | 6 | 1400 | 1746 | 118 | 2.68 |
| 300 | 8 | 1800 | 1770 | 117 | 1.98 |
| 360 | 12 | 1800 | 1950 | 124 | 2.57 |
| 800 | 6 | 1200 | 2400 | 127 | 2.25 |

The high rotational speed of the aero-engine is the first point to consider; such speeds are used solely to reduce weight. It becomes, therefore, a question of how far can we advance by using a lower speed with a simpler form of design. The latest experience with the plain six-cylinder line ahead engine indicates that a good deal more can be done than at first sight seemed possible. For instance, 1800 lb. weight for 800 brake horse-power, and undoubtedly this is a much more suitable type for a crude oil engine. The speed of revolution is 1200. Will the injection gear work at this speed? No doubt special forms will, as practical testing has shown.

Looking at the next column, *i.e.*, piston speed, this does not present any great difficulty, for that of the above engine with a 12in. stroke is 2400ft. per minute; obviously, this is a great gain in our weight cutting. *Inter alia*, it is not the piston speed so much as the high number of reversals of the high rotational speed that affects the life of an aero-engine.

In the next column we have the mean pressures. Here is the crux of the matter; to get a mean pressure 50 per cent. higher than that of the submarine Diesel under the high-speed conditions of the aero-engine, nothing but very special means and probably long experimental work will solve. There is one way of boosting this pressure, and that is by the addition of further air than is normally drawn in by the piston, and the author has had some success in this method.

Finally, light alloys must be used to the maximum extent in the engine to save weight at every corner. With all this, the problem would still seem unsolved when the higher pressure of the injection crude oil motor is taken into account. Actually it is not so, for much good development work has been done at Farnborough.

The Junkers engine has obtained a certain amount of publicity, but the author thinks this was but an experimental type and never ran on heavy oil. When he last saw it it was quite out of use. The Beardmore 600 brake horse-power engine weighs approximately 3 lb. per brake horse-power and runs on Mexican oil of .9 specific gravity. It is hoped to give more details of this engine at a later date.

Despite the attractive features of the crude oil aero-engine, the author desires most seriously to draw attention to the danger of overlooking the further development of the present type through concentrating too much attention on it. There is room for both. The present type will always be a lighter type, and for short journeys this may always prove a superior attraction, also for high speeds, as for military scouts. It should be the object of designers of the present type to attain an engine of still greater reliability, of a higher fuel economy and lighter weight.

It is not impossible to make an engine of 1 lb. weight per horse-power, and if he might, the author would suggest still better cooling of the combustion chamber, particularly the exhaust valves, to allow of higher compression ratios, and the more extensive use of light alloys, as two important factors of the problem.

Mr. Fedden opened his remarks with a brief review of the development of the static radial air-cooled aero-engine :—

Although, he said, the static air-cooled radial engine is by no means an innovation in the history of aero-engine development, its career has been a somewhat chequered one. Some ten years ago several practical low-powered air-cooled radials were produced, but they were ousted by the rotary on the score of power/weight ratio.

Again in 1918, the limit of the air-cooled rotary having been reached, a demand arose for an engine of the same characteristics of manœuvrability, compactness and light weight as the rotary, but of much higher power, and with a general all-round performance and fuel consumption comparable with the water-cooled engine of that date.

The most promising solution seemed to be the static air-cooled radial of 300–400 horse-power, and much attention was drawn in 1918 to this type of engine. Several designs were developed, and although an excellent power/weight ratio was obtained, the promise given by these engines in the first preliminary stages was not realised. Serious failures developed, and designers of aircraft preparing new machines for these engines were disappointed and held up indefinitely for their power units; thus the static air-cooled radial received a serious setback.

We have now arrived at the time when this type of engine is a proved proposition. Its performance as regards reliability, life, and fuel consumption is such that it must be reckoned with the best water-cooled engines of to-day.

Whereas it is not suggested that the static radial air-cooled engine is unequalled for all types of aircraft, and it is admitted that the successful development of this type of engine has been a long and tedious operation, and a certain amount of weight been conceded in the course of its development, nevertheless it is confidently believed that this engine will hold the field against all comers for certain classes of military and commercial work, at any rate for the next ten years, in so much as a 400 horse-power engine of this type, complete with exhaust manifolds, air intakes, &c., comes out 25 per cent. lighter than the very best water-cooled engine with the same equipment plus radiator and water, and within the next twelve months it will be possible to improve the power/weight ratio of the air-cooled engine on the same basis by a further 12 per cent.

Having outlined some of the advantages and disadvantages of the static air-cooled radial aero-engine, and having analysed some of the problems peculiar to this type of engine under review at the present time, Mr. Fedden proceeded to deal with the problem of the air-cooled engine as affected by altitude :—

Generally speaking, he said, the same problems have to be faced with radial air-cooled engines at altitude as water-cooled engines, but owing to the interest in altitude engines for commercial and military purposes at the present time, some points peculiar to air-cooled radials will not be out of place. The air speed of an aeroplane falls off as the height increases, due to decrease in engine power owing to the decreased density, and in spite of the fact that the power required to maintain constant air speed diminishes the higher the altitude.

There are various methods of obtaining increased power at altitude, but the question of maintaining constant power with an air-cooled engine is a difficult one, in so much as the air-cooling effect decreases with altitude owing to the decrease of air density. The various practical forms of maintaining power at altitude with static air-cooled radials are as follows :—

(1) A gear-driven blower.
(2) An exhaust-driven turbine with centrifugal blower.
(3) A high-compression engine with bi-fuel system.
(4) A high-compression engine with oversize cylinders.

The first scheme does not appear very promising; a considerable amount of power is necessary to drive the blower, with a consequent increase in fuel consumption, and the gearing and engaging mechanism is also a very difficult problem; also, as the gear-driven blower runs at a constant speed, it is wasteful at low altitudes.

With scheme No. 2 the turbine should be to a certain extent self-regulating, because with an increase in altitude there is a decrease in power. The mechanical problems are not anything like so great, but the heat problems of the air-cooled engine are considerably increased.

The actual problem of the centrifugal blower has already been solved on other types of engines, and it is believed that by careful experimental work it will be possible to evolve a type of static radial air-cooled engine in which the exhaust-driven turbo-compressor is satisfactory. The problem is also an attractive one in so much as the advantages offered are so great. It is estimated that in order to maintain ground level power to 15,000ft. an increase of 150 lb. will be necessary.

As an intermediary step, however, it is believed that either the third or fourth scheme—the bi-fuel or oversize engine—offers the most promising solution. In the former case the carburation system of the engine is duplicated, a 7 to 1 compression ratio is used, and alcohol fuel employed near the ground, the mixture being changed over to petrol as normal compression and altitude is reached. With this scheme, however, there is the disadvantage of using two fuels, and the consequent complication of dual tanks and controls. There are, however, no additional complications to the engine, and the running on alcohol fuel with 7 to 1 compression ratio is very satisfactory, the general engine temperature being slightly less than with 5 to 1 compression ratio and petrol.

With the fourth scheme an oversize engine is used which will be opened out only to rated power on the ground. It is necessary that this engine should be designed for the purpose, and not be an existing adaptation. It is also absolutely necessary that the control mechanism of the aeroplane should be such that the pilot cannot open out the engine on the ground, otherwise damage will inevitably accrue. With these two latter schemes there is the definite advantage that there are no additional complications to an existing proved principle, and the heat problems of an air-cooled engine are not increased.

The Chairman said that the low temperature testing department at Farnborough, which was quite unique and had cost a large sum of money, ought to permit valuable results to be obtained at an early date. A great deal had been heard in the papers regarding fuels and the cost of fuels, but too much importance should not be attached to the question of cost, as consideration must be given to the quantity of a particular fuel available and the ease with which it could be obtained. Emphasis had been laid, too, on the advantages of the compression ignition engine, and he believed that with this type of prime mover the repair figures should be remarkably low. He had recently had access to some figures dealing with the repair bills of various types of engine, and they varied as much as 10 to 1, which indicated the importance of this aspect of the subject. Wing-Commander Hynes had referred to the electrical indicator, but he had not emphasised the fact that it was necessary for an indicator of that type to give simultaneous results from all the cylinders. That type of indicator was very accurate and gave figures which enabled definite comparisons to be made between one engine and another. Mr. Chorlton had referred to an engine weight of 4 lb. per horse-power, but he did not say whether that was an all-in figure.

Captain F. M. Green remarked that Mr. Chorlton had referred to the question of explosion pressure. The maximum pressure in a petrol engine under ordinary circumstances might only be from 350 lb. to 400 lb. per square inch, but every engine was subject to abuse, and he had recorded pressures of 600 lb. per square inch, and provision must be made by the designer for such pressures. If the crude oil engine could not be reduced in weight below 4 lb. per horse-power he feared it would not be much use to the aeroplane designer, and an effort would have to be made to reduce the weight before the economies which could be realised in other directions could be regarded as worth attention. Mr. Fedden had put the case extremely well for the static radial air-cooled engine, and he agreed with him on most points. He thought, however, that a time of 8 hours for taking down such an engine was very high for two mechanics, as during the war period within his own experience two women workers had found it possible to strip a water-cooled engine of 250 horse-power in less than two hours. He thought Mr. Fedden was a little modest in his statement that the petrol and oil consumption of the static radial air-cooled type of engine was not quite so good as the best water-cooled engine. In his (Captain Green's) experience, it was equal in this respect to the average water-cooled engine. Mr. Fedden was a little doubtful as to the advantages of the double-row engine, but speaking from experience of both the single and the double types, he was able to say that there was no difficulty in cooling the double-row engine because it was of smaller diameter. With regard to the influence of altitude it appeared from tests carried out by Dr. Gibson that the effectiveness of the fins increased with height. There was less difficulty in keeping the super-charged engine cool at high altitudes than Mr. Fedden suggested. He would draw attention to the possibilities among other systems of supercharging of the direct-driven gear method.

Dr. E. B. Wolff said that it would be desirable to have some definite statement from those in authority on the subject of the suggested weight of 4 lb. per horse-power referred to by Mr. Chorlton. Reference had been made to maximum pressures, and he had seen these rise to as high a point as 800 lb. per square inch. On the subject of fuel consumption he had had experience with petrol of as low a figure as .38 lb. per brake horse-power.

Wing Commander Cave-Browne-Cave asked Mr. Chorlton to give more information as to the method of starting the heavy oil engine. No satisfactory system had yet been devised for starting the ordinary aircraft engine, and he hoped that Mr. Chorlton had made an advance in that respect. On the subject of weight per horse-power the relation between weight and fuel economy was very definite, and he would have imagined that the fuel economy associated with the pressure ignition cycle would justify a weight of 4 lb. per horse-power. Mr. Fedden had indicated what could be achieved with an air-cooled engine. The principal difficulty with that type of engine was the cooling of the valves, and it would be of interest to know if consideration had been given to the use of a single or double sleeve or cuff valve.

Mr. E. A. Evans, dealing with the starting problem, said that in cold tests even down to – 45 deg. the oil was sufficiently viscous to enable the engine to run. More information was wanted on the subject of anti-detonating mixtures, but a good deal of the research was of a secret character. If details could be given of the work done in this connection at the R.A.E., it would be a great advantage to those who were dealing with these problems. The question of corrosion was important. It had been suggested that it was due to acidity in the oil, but corrosion had taken place in engines kept in store. It was a point which should receive fresh attention so that the relative effects of oil and the atmosphere could be ascertained. It was a subject which called for a joint effort by engineers and chemists. Mr. Fedden had referred to an oil temperature of 50 deg., but possibly this figure referred to mineral oils, as with other oils it was possible to work at higher temperatures quite safely. Mr. Chorlton mentioned oils of a specific gravity of .9, and it was a common practice of some engineers to distinguish oils in this way, although the specific gravity figure had very little connection with the quality of the oil. It was known that oils within the same range of gravity had varying viscosity and other qualities, and it would be better to rely on

viscosity and other tests rather than gravity tests.

Mr. J. L. Chaloner raised the question of fuel consumption figures. It was possible to-day, he said, to obtain figures with the petrol engine which compared more favourably than was the case a few years ago with the consumption figures of the Diesel oil engine. The truth was that the percentage of fuel costs to total costs of operation was becoming smaller and smaller, and it was necessary to pay more attention to some of the other items in the bill of total cost. Mr. Chorlton was apparently not in favour of the two-stroke engine; but this type was attracting more attention, and he believed it could be made quite as reliable as the four-stroke engine. In connection with injection methods, dual chamber combustion was coming to the front, and important developments were anticipated in this branch of work. On the subject of speed of revolution, he would remind the meeting that commercial engines were now running at 1800 revolutions per minute, and that maximum speeds of 2400 revolutions were quite possible.

Wing-Commander Hynes said, in reply to some of the questions asked, that with the electrical indicator a four-cylinder engine had been indicated on one card, and that the same achievement ought to be possible with the six-cylinder engine. The degree of accuracy obtained was very great, but an element of doubt had been suggested by Mr. Ricardo with regard to the type of seating used for the disc valve. On the subject of the highest pressures which had been recorded, he believed that something over 1000 lb. per square inch had been reached in a German engine. He did not think that any great difficulty would be experienced with cooling arrangements for the super charged air-cooled engine. A question of supercharging, to which attention might be directed, was the use of the exhaust driven turbine. He did not think it was correct to say that all forms of supercharging took power from the engine. The use of the exhaust driven turbine was a contrary case in point, as the energy required was taken from the exhaust gases, and the back pressure on the engine was never more than 2 lb. per square inch. He was much interested in the point raised by Dr. Wolff as regarded fuel consumption figures, the figure quoted being an extremely low one. The anti-detonating problem was a very important one, and some extraordinary results could be secured. Methods of protection from corrosion had not received a great deal of attention, but an experiment was now in progress which made use of zozol and the fat from sheep's wool.

Mr. Chorlton claimed that the weight of the engine would not necessarily be 4 lb. per horse-power. On the subject of pressures, he agreed that provision must be made in the design for higher pressures than the normal which complicated the weight question, and it was unreasonable to expect that pressures with the crude oil engine could be reduced to compare with the weight of the petrol engine. He, like others, was surprised at the figure of .38 lb. per brake horse-power, quoted by Dr. Wolff, in view of the fact that the ordinary figure was about .5 lb. per brake horse-power. The starting up of the engine was an important point. Experience indicated that the best method was to start the engine mechanically with the valves lifted. The fire risk was, he thought, less than in the case of an engine in which a carburetter had to be fitted. He agreed that the development of the two-stroke type of engine was extremely probable. There seemed to be a little misapprehension on the speed question, and advocates of high speed must not forget the need at the same time of obtaining a satisfactory mean effective speed.

Mr. Fedden, dealing with the fuel question, said he had used alcohol with acetone with satisfactory results. Regarding fuel consumption it was very difficult to state what could be achieved by the water-cooled engine. Reference had been made to the double and single row air-cooled engines, and no doubt there were applications for both types. Wing-Commander Cave-Browne-Cave had referred to the question of valves, and he was able to say that good results had been obtained with the valves of air-cooled engines. The air-cooled engine had, he believed, a great future for airships, and would perhaps meet even Commander Cave-Browne-Cave's severe requirements in connection with the power plant of lighter-than-air machines.

Professor W. E. Dalby presided over the meeting of another Section, at which Dr. L. Aitchison presented a paper on "The Development of Aero-Engine Materials," of which an abstract follows:—

### "THE DEVELOPMENT OF AERO-ENGINE MATERIALS."

By LESLIE AITCHISON, D.Met., B.Sc., F.I.C.

The essential properties of a constructional material are not dependent upon the particular industry in which the material is employed. Under every circumstance an engineering material of construction must possess two very definite properties. The first property is strength, in a reasonable and predetermined measure; and the second is permanence or durability. In aircraft, whether in machines or in engines, a third property is always desired, namely, lightness. This, however, is really only a component part of the strength property. What should be actually regarded as important is that the strength per unit mass shall be as high as possible. It is obvious that the strength/weight ratio of a part can be increased within limits by utilising either a material of higher strength and the same weight per unit mass, or a material of lower specific gravity and approximately the same strength. Aircraft engines probably represent in both these directions the maximum attainment in the world up to date.

Permanence or endurance in a material involves a number of properties. It certainly means that the material under its working conditions shall not deteriorate either intrinsically or by corrosion or by scaling, or the like. It also infers, moreover, that the material shall be reliable and sound and up to type. It must not be a material that gives very satisfactory sample tests and yet is quite unsatisfactory under manufacturing and working conditions in consequence of undetected unsoundness. The deterioration of an aero-engine material by corrosion or by oxidation or scaling is not likely to occur except under special conditions, and these will be referred to later. In brief, therefore, the essential properties of an aero-engine material become simply two, namely, a high ratio of strength to weight and the greatest possible reliability.

In nearly every part of an aero-engine the material is exposed to fatigue stresses. The high strength/weight ratio means, therefore, that the material shall have a high ratio of fatigue strength to specific gravity. The fatigue strength of aero-engine steels is found to be between 42 and 52 per cent. of the maximum stress—the actual range is double this proportion, *e.g.*, for a maximum stress of 60 tons per square inch the fatigue range would be perhaps ± 30 tons per square inch. The fatigue range of light alloys does not appear to be such a high percentage of the maximum stress as that of steel. The yellow metals similarly have fatigue ranges which are less in proportion to the maximum stress. In a comparable form the light alloys or the yellow metals appear to have a fatigue strength which is 35 to 40 per cent. of the maximum stress. In the evaluation of the strength value of aero-engine materials it is evidently, therefore, most convenient to make comparisons amongst the ratios given by dividing the above-mentioned proportions of the maximum stress by the specific gravity. It appears to be a perfectly safe and proper thing to estimate the strength value of a material of construction from this fatigue range/weight ratio. In the table below are set out a number of these ratios for materials that may be used by the aero-engine designer.

| Material. | Max. stress, tons per sq. in. | Specific gravity. | Ratio of fatigue range to specific gravity. |
|---|---|---|---|
| Steel—100-ton (S. 28) | 101.2 | 7.85 | 6.56 |
| Steel—60-ton (K. 1) | 65.7 | 7.85 | 4.20 |
| Steel—35-ton (S. 6) | 37.9 | 7.85 | 2.16 |
| Steel—35-ton (S. 1 pt. i.) | 36.2 | 7.85 | 2.16 |
| Steel—Ni. case hardening (S. 15) | 65.5 | 7.85 | 3.95 |
| Steel—case hardening (S. 14) | 39.5 | 7.85 | 2.34 |
| Muntz metal | 29 | 8.5 | 1.47 |
| Delta metal | 36 | 8.5 | 1.24 |
| Brass | 34 | 8.5 | 1.47 |
| Drawn bronze | 35.6 | 8.6 | 2.04 |
| Corronil | 42 | 8.87 | 1.85 |
| Annealed copper tube | 13.5 | 8.78 | 0.37 |
| Annealed arsenical Cu tube | 14.5 | 8.78 | 0.50 |
| Duralumin | 25.6 | 2.81 | 3.72 |
| Y alloy | 24.2 | 2.85 | 3.58 |
| 3/20 alloy | 25.0 | 3.1 | 2.80 |
| Cast Al/Zn alloy L. 5 | 11.0 | 3.0 | 1.0 |
| Cast Al/Cu alloy L. 11 | 9.0 | 2.88 | 1.04 |
| Cast Al/Cu alloy L. 8 | 10.0 | 3.10 | 0.97 |

The ratio of fatigue range to maximum stress of a cast metal, speaking generally, is very markedly lower than the fatigue ratio of the same material forged. For steel it appears that the fatigue ratio of the material as cast is at least some 40 per cent. lower than the fatigue ratio of the same material after it has been forged or rolled. From such tests as are available upon light alloys it appears that these when cast are inferior to the wrought alloy by at least this proportion. From simple strength/weight considerations it is evident that there is a marked advantage to be gained regularly from the use of a forged material as opposed to a cast material, whatever of the customary metals may be concerned. Consequently it appears to be very highly desirable that the aero-engine constructor should utilise forged materials wherever possible.

It can be stated with fair confidence that most of the materials that are ordinarily incorporated in an aero-engine can be obtained in the wrought state. Steel, of course, is always wrought, either rolled or forged. The light alloys and the yellow metals are not so regularly wrought, and it is in regard to such materials that the greatest change is likely to be required. Nevertheless, amongst the light alloys duralumin does undoubtedly offer very valuable mechanical properties. Also, it must not be forgotten that many of the magnesium alloys can be wrought satisfactorily and that in this state they have mechanical properties that are very useful. It appears actually that the alloys of magnesium are likely to be much more useful in engines than in machines. The yellow metals are not extensively employed except in connection with bearings. Even for such parts there is a marked advantage in the use of wrought metal as opposed to cast metal, particularly in the reduction in scrap that is effected by the use of the wrought metal. Cast phosphor-bronze bearings are often very unsound, and if they can be replaced by drawn tubing a great benefit is always experienced.

The principal kind of defect in aero-engine material is the internal defect that is hidden from the view of the user of the part. External defects are, of course, almost equally dangerous, and the aero-engine builder takes very great pains as a rule to eliminate such defects. All surfaces are usually machined with the greatest care, and the inspection of these surfaces is exemplary. A model amount of care is expended in the examination of internal machined surfaces and such like places. Despite this, it is quite general for the aero-engine builder to employ valve springs, on the material of which there has been little inspection, and of whose condition the engine builder is relatively ignorant. The disparity between the care with which a valve and a valve spring are examined is enormous, and yet presumably one is as important as the other. In view of the very frequent failures that are experienced in respect of valve springs and which in a very large majority of instances are due to the presence of surface defects, cracks and rolling flaws, it is evidently desirable to utilise that form of material which is most likely to produce the greatest freedom from such defects. Actual experience leads to the conclusion that a bright drawn wire of a strength approximately equal to that produced by the ordinary method of hardening and tempering gives the maximum immunity from failures due to bad surface.

Sir Robert Hadfield said that the paper showed quite clearly the extreme ranges of stress which had to be provided for in materials used for aeroplane construction. The Stanton test gave a great deal of valuable information to those engaged in the production of parts of aeroplane engines. The question of the erosion of valve materials was important, and more information was wanted if the trouble was to be overcome. He believed that metallurgists would rise to the needs of the occasion. Dr. Aitchison had referred to the use of rustless iron, and he, personally, believed that there was an important future for that material. The corrosion problem was now attracting a great deal of attention, and in particular Dr. Hatfield had done useful work in that field.

Dr. W. Rosenhain commented on the wide range of subjects covered by the paper. The idea of fixing the value of materials upon the ratio of fatigue range to weight was excellent, but he would point out that the material having the highest fatigue figure was not necessarily the best for all purposes. There were other essential qualities; machinability was one; power to resist shock was another. Moreover, fatigue was not a constant property at high temperatures, such as were experienced in aeroplane work. The $\gamma$ alloy, which had a tensile strength figure of 21 tons (26 tons had been obtained), a fatigue range of 7 tons and a ratio for fatigue density of 2.5, should be included in the author's table. He concurred in the desire to see forged and rolled material substituted for castings wherever possible, owing partly to the fact that rolling and forging and working materials revealed defects which escaped notice in the casting. A method of testing castings for defects was made available by the use of X-ray examination.

Dr. W. H. Hatfield reminded the meeting that it was impossible to produce the somewhat complicated large castings for aero work free from shrinkage defects. Nothing but forged material should be used in aero-engines of large power. In the case of welded material, too, it was not possible to be certain that the parts were definitely united. A good deal of work was now being done to develop a suitable material for aero-engine valves. Rust-resisting steels, particularly the high chromium steels, were now available in strip, cold rolled strip, and in the form of tubes.

Mr. Roger Menetrier agreed with the objections raised to the use of castings. In his opinion it was necessary to investigate, not perhaps fatigue, but the progressive strain effect in all materials for aircraft construction. He had experienced a good deal of trouble from stress in big end bolts. There was the static stress caused by tightening the nuts, and then the working stress. Great difficulties occurred also in the case of valves, especially in connection with the attachment of the valve springs.

Mr. A. E. L. Chorlton referred to the heat treatment of castings. No reference was made in the paper to the 13½ per cent. silicon alloy, of which he had favourable experience. In engines in cross-Channel service aeroplanes, gudgeon pins and big ends had given most trouble.

Mr. G. P. Bulman, speaking from the standpoint of an inspector of materials, said that the Stanton test was not part of the final process of inspection. Carburetters caused the most trouble. One very severe case of corrosion in carburetters was definitely traced to the fibre washers which were provided at the joint. They were found to contain a high percentage of zinc chloride, and the trouble was overcome by treating the washers with glycerine.

Professor Dalby concurred as to the advantages claimed for the $\gamma$ alloy, but said that supplies of this material were very short. It was really not on the market.

Dr. Aitchison agreed that the ratio of fatigue range to density was not an absolute criterion of aero-engine material. He did not think fatigue at high temperatures was of much account, except in the case of pistons. There had been very little trouble with steel jackets. The suggested X-ray examination of castings would be very difficult owing to the size of aero castings. He was no advocate for the welding of aeroplane parts. He hoped to see greater use made of stainless steel and iron.

## The Rapid Corrosion of Condenser Tubes.

By GUY D. BENGOUGH, M.A., D.Sc., and R. MAY, A.R.S.M.

THIS is a brief account of its authors' conclusions as to the cause of the rapid corrosion of condenser tubes which has sometimes occurred during the last few years. The work of investigating the matter has been carried out under the direction of the Corrosion Research Committee of the Institute of Metals, the chairman of which is Professor H. C. H. Carpenter, F.R.S. The evidence that has been collected is very voluminous, and is shortly to be presented in more detailed form to one of the engineering societies interested in the matter; in this article little more than a general survey of the subject will be attempted.

### THE PROBLEM.

The article deals only with corrosion caused by the presence of entangled air in the circulating water, in estuarine and marine conditions. The attack is specially serious because it can cause tube failure in a few weeks or even days.

This cause is largely independent of the chemical composition of the tube, *i.e.*, any ordinary tubes of commerce of 70:30 brass, Admiralty alloy, lead brass or arsenical copper will show the action when exposed to suitable conditions. In fact, any selected area of any ordinary tube is liable, and can be made, to show the action. Certain alloys very high in nickel, *e.g.*, containing 70 per cent., resist the action well, copper alloys containing up to 20 per cent. nickel fail as badly as brasses.

The action which produces the rapid failure has

certain characteristics, of which the following is a list :—

(1) It usually occurs near the water inlet of the tubes in the first pass, less frequently near the water outlet of long tubes.

(2) It occurs indifferently anywhere round the circumference of the tube, and frequently all round it. A considerable area of tube is attacked, *i.e.*, the action is not concentrated at sharply defined isolated pits.

(3) A longitudinal section of a tube corroded by this action when rubbed down on an oil stone shows a characteristic "water worn" appearance, from which the direction of the flow of the water can be readily determined.

(4) The tubes showing the action are often found to be spaced over a comparatively small area of the tube plate. If a corroded tube be replaced by a new tube, the latter will often again fail rapidly, and the process may be repeated several times.

(5) The action is seldom shown by tubes that have been a long time in the condenser, *i.e.*, tubes either show it in their early life or not at all.

(6) Ordinary methods of electrolytic protection fail to prevent the action.

(7) Metallic copper is seldom found as a corrosion product at the corroded areas; these often seem remarkably free from corrosion products.

(8) Ferrules occasionally show the action. These are frequently made of 60 : 40 alloy, but even in such cases it often happens that no metallic copper is visible at the corroded surface.

These characteristics are illustrated to some extent in Figs. 1 to 7. Fig. 1 shows the distribution of corrosion along a tube 16ft. in length. Fig. 2 illustrates the attack on a shorter tube.

Fig. 3 shows a typical distribution round the circumference, and Fig. 4 the "water worn" appearance of a longitudinal section.

Fig. 5 shows the appearance of a corroded tube in plan.

Fig. 6 shows a corroded ferrule.

Fig. 7 shows a typical distribution of the corroded tubes over a tube plate.

The shortest period in which tubes have failed in the authors' experience, owing to the cause in question, is seventeen days. This is unusually rapid, and the failures took place in rather special conditions. Several instances have occurred of failures within six weeks, and failures within a year have recently become fairly common. Tubes which have lasted more than two years in a condenser have rarely, in the authors' experience, shown all the characteristics of the action outlined above.

The action has usually been found to occur in condensers associated with turbine plants in which high efficiency is necessary. A high average water speed, such as 7ft. or 8ft. per second, and a high vacuum, such as 28½in., which conduce to condenser efficiency, appear to favour the action. No case is yet on the authors' records in which this type of tube failure has occurred in reciprocating plants with a vacuum of less than 26in., and an average water speed of less than 4ft. per second. So far the action has only been observed on tubes in waters high in chloride, such as estuarine and sea water.

### THE INVESTIGATION.

In investigating the question it was first necessary to decide whether the cause was to be found in the tubes or in the conditions to which they were subjected. This question was finally decided in the sense that the main cause of the action must be in the conditions. The evidence for this may be briefly summarised as follows :—

(1) It was found on several occasions that tubes even when made by different makers failed one after the other in the same positions in a condenser, each successive tube failing at similar positions along its length. It is incredible that all such tubes could have happened to have been faulty at these positions. Other tubes from the same batches in the same pass stood up satisfactorily.

(2) Records of tube failures showed results of the type illustrated in Fig. 7, which represents the tube plate of a two pass condenser. It will be seen that the tube failures occurred almost exclusively in two small areas of the condenser; this usually happens even when the batches of tubes made by different makers are interchanged.

(3) Tubes ascertained to be of good commercial quality as regards composition and physical properties when introduced into condensers previously known to be specially corrosive have failed rapidly in certain positions.

(4) Tubes from the same batch have stood up satisfactorily in other positions and in other condensers.

(5) Tubes from the same batch have failed rapidly under a laboratory test designed to imitate the suspected harmful conditions, and described below.

(6) Tubes of widely different compositions have failed in conditions known to be severe on ordinary 70 : 30 brass tubes.

The question then arises as to the possible variations in conditions that may occur in different parts of the same pass of the same condenser. At first sight it appears that all the tubes in a single pass must be in similar conditions, and should, therefore, behave similarly if of uniform quality. Closer observation has shown, however, that this is by no means the case.

It has been generally assumed in discussions on condenser practice that the speed of the water through any given tube in a condenser is approximately identical with the average speed through the whole condenser. This average speed is usually known, or, at any rate, it can be calculated with reasonable accuracy, but it has been found experimentally that the actual speed near the wall of any given tube may differ widely from the average speed. It is the speed at the tube wall that is important from the corrosion point of view. The matter has been investigated by the use of glass tubes of similar internal diameter to condenser tubes, and held in tube plates by ferrules of the ordinary design, the tube plates being attached to C.I. water ends in the usual way. A centrifugal pump was used to supply the water.

The phenomena of flow observed in the tubes varied considerably with the type of water used in the experiments. The behaviour of sea water only will be discussed in the present article. The first point of importance to be noted is that smooth flow, such as is usually assumed to take place through all condenser tubes, did not take place through many of the tubes. In certain tubes the water stream formed vortices or more or less flat or extended spirals, especially for the first 2ft. or 3ft. of the tube. See Figs. 10 and 11. Where these spirals impinged on the walls local turbulence was set up—as shown in

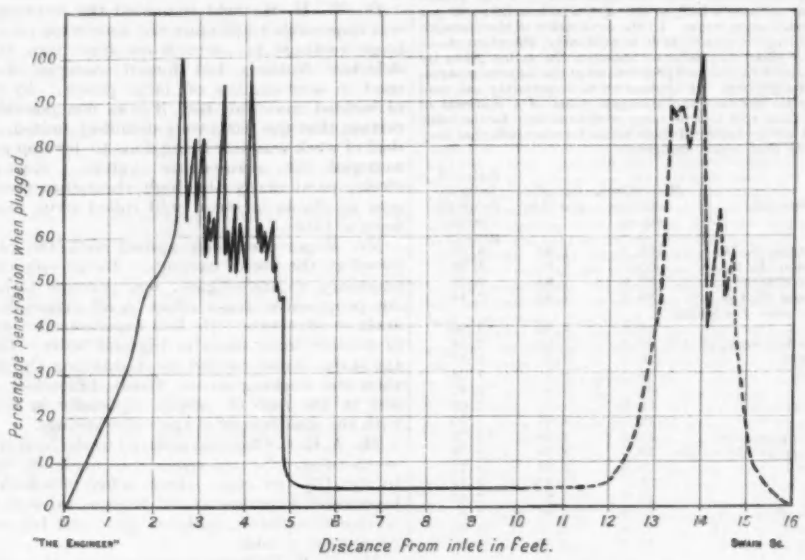



FIG. 1—DISTRIBUTION OF CORROSION IN A SIXTEEN-FOOT TUBE

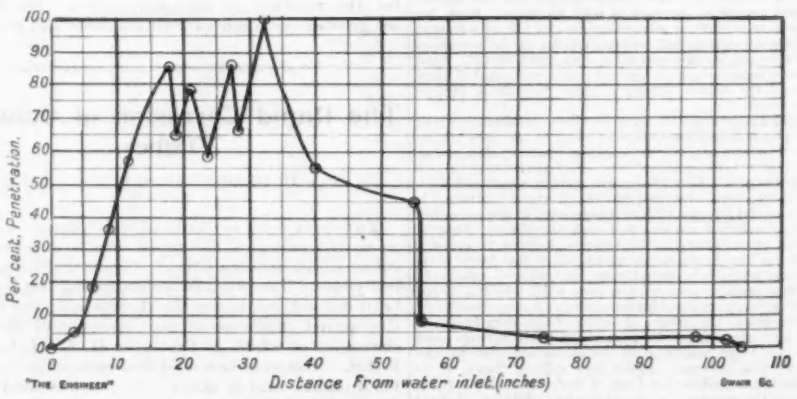
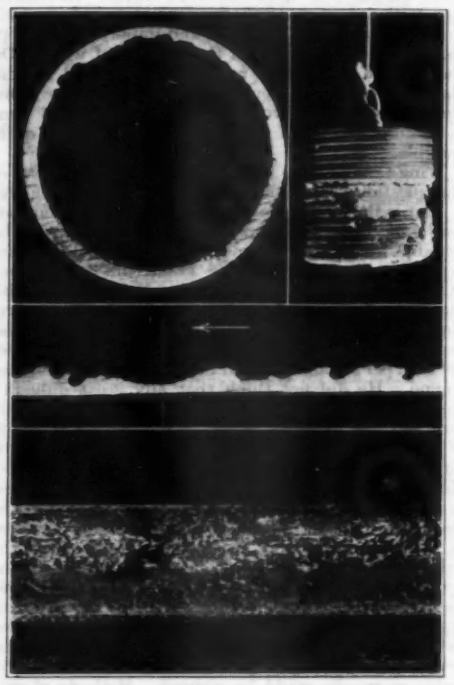



FIG. 2—DISTRIBUTION OF CORROSION IN A NINE-FOOT TUBE



FIGS. 3 TO 6

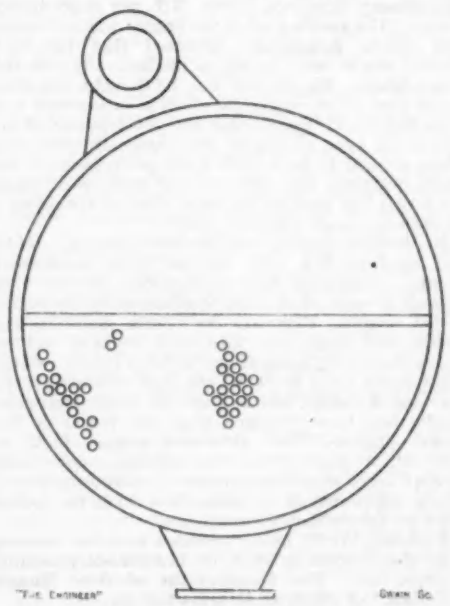



FIG. 7

Fig. 11. Some approximate measurements were made—by a photographic method—on the variations of speed that occurred at various parts of the tube. For this purpose the introduction of small solid particles or air bubbles was useful; the behaviour of these showed clearly that great variations of speed could take place even in a single tube. Thus at certain parts of a tube through which water was travelling at an average speed of 6ft. per second local retardation near the tube wall might reduce the speed almost to zero, while in the centre of the tube the speed might approximate to twice the average speed. Turbulence prevailed in different degrees in many of the tubes for a length of 2ft. or 3ft. from the inlet end and then gradually died away. When turbulence prevailed high water speeds might be attained locally near the tube wall. The actual amount of water passing through a given tube was, of course, greatest in the tubes with least turbulence, *i.e.*, with the nearest approach to smooth flow. Probably the highest speeds were developed locally in tubes with the greatest turbulence. The phenomena differed noticeably in tubes in different positions relative to the main water inlet. Some tubes showed scarcely any vortices but local impingement on the tube wall near the inlet end—as shown in Fig. 9.

An increase in the water speed increased the complexity of the phenomena; a decrease to 2ft. or 3ft. per second caused an approximation to smooth flow to take place throughout the greater part of the tube.

It had previously been found experimentally that an increase in water speed, at least up to about 20ft. per second, increased the rate of corrosion of both copper and brass; consequently, the greatest local corrosion would be expected where the greatest turbulence prevailed, *i.e.*, near the inlet end.

Nevertheless, the failure of tubes in practice in a few weeks could not be explained on the basis of high water speed alone. Even with the highest water

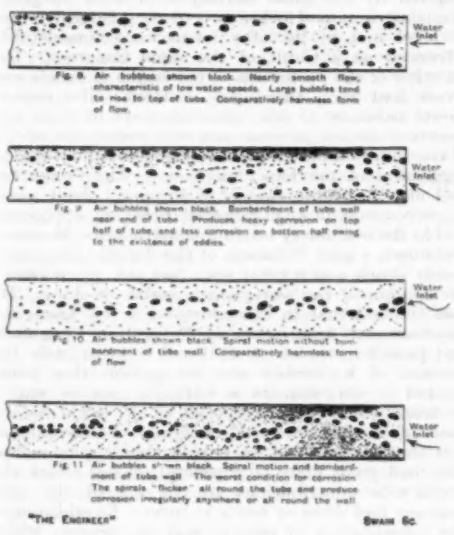



Fig. 9. Air bubbles shown black. Nearly smooth flow, characteristic of low water speeds. Large bubbles tend to rise to top of tube. Comparatively harmless form of flow.

Fig. 9. Air bubbles shown black. Bombardment of tube wall near end of tube. Produces heavy corrosion on top half of tube, and less corrosion on bottom half owing to the existence of eddies.

Fig. 10. Air bubbles shown black. Spiral motion without bombardment of tube wall. Comparatively harmless form of flow.

Fig. 11. Air bubbles shown black. Spiral motion and bombardment of tube wall. The worst condition for corrosion. The spirals "flicker" all round the tube and produce corrosion irregularly anywhere or all round the wall.

FIGS. 8 TO 11

speed used in the experiments, namely, 25ft. per second, a copper tube would have a life of at least six months, at laboratory temperatures.

## AIR THE CAUSE.

When working with sea water a phenomenon was encountered which was not observable with certain other types of water, namely, the sea water always contained a small amount of air in very fine bubbles. These were evidently due to a certain amount of churning in the centrifugal pump which had caused them to pass out of solution. They retain their identity for considerable periods in this particular water for the same reasons which cause it to exhibit the familiar property of foaming, which is not possessed by many fresh waters. The presence of these small bubbles was found to be useful in working out the movements of the sea water in the tubes, and additional air was added to the main water stream before it reached the water end by means of a needle valve which acted as an adjustable leak. Many striking phenomena were then observed with different arrangements of inlet pipe to tube. In particular, the bombardment of the tube wall with air bubbles at certain areas was noticed, and it seemed possible that such a bombardment might affect the rate of corrosion at such places.

Accordingly some comparative tests were made in which the corrosive effect of sea water containing only dissolved air in normal amounts was compared with that of the same water containing, in addition, mechanically entangled air. The results were very striking, and a few are shown in the following table. In the case of brass condenser tubes it will be seen that the rate of corrosion is greatly increased when a certain small volume of entangled air is exceeded; thus with 3 litres of air per hour passing through the tubes their lives would be only about three months in the cases shown in Table I. These tests were carried out by impinging a jet of sea water containing

TABLE I.—*Corrosion of Brass Tubes* (18 W.G.).

| | |
|---|---|
| Time of experiment .. .. .. | 28 days |
| Temperature .. .. .. .. .. | 20 deg. Cent. |
| Speed of water .. .. .. .. | 10ft. per second |

| Alloy. | Per cent. penetration on 1.21 mm. = 18 W.G. | Amount of entangled air in c.cm. per hour. |
|---|---|---|
| 70 : 30 .. .. | Less than 1 | 0.7 |
| 70 : 29 : 1* .. | 2.5 | 0.7 |
| 70 : 30 .. .. | Less than 1 | 25 |
| 70 : 30 .. .. | Less than 1 | 145 |
| 70 : 30 .. .. | 31 | 3,000 |
| 70 : 29 : 1 .. .. | 35 | 3,000 |
| 70 : 30 .. .. | 83 | 11,000 |

* Laboratory cast specimen.

air on to the surface of the tube arranged at right angles to it.*

The total volume of air, however, is not the only factor in the case; another important one is its state of subdivision. A given volume of air is more harmful in a fine state of subdivision than when present in large bubbles. A fine foam appears to be the worst possible case. A foam consists of an intimate mixture of air and water, from which the air does not readily separate.

Very small amounts of certain liquids and solids can greatly stabilise foams, that is, prevent the separation of the air, *e.g.*, certain oils and basic salts. Notable differences in the tendency to foam have been encountered between samples of sea water collected in large stoneware jars and successively filled from the same position on a jetty; such differences may have a noticeable effect on corrosion. As a rough generalisation it may be said, however, that the penetration of a tube per month by an air-sea-water jet containing three litres of air per hour in the conditions of Table I. varies from 26 per cent. to 33 per cent. for the ordinary run of 70 : 30 tubes of commerce. With a highly foaming batch of water higher penetrations are occasionally observed, the highest yet recorded being 49 per cent. These experiments were usually carried out with sets of twelve tubes at a time, and it was clear that the varying results were due to the conditions rather than the tubes, since if one tube gave a high result all the others in that set did so. In all cases the type of corrosion strikingly resembled that which occurs in conditions of ordinary practice.

A small amount of sulphuretted hydrogen in the water, such as is occasionally found in conditions of practice, greatly enhances the rate of attack; thus, with sea water containing 3 c.cm. of the gas per litre, penetrations of 82 per cent. and 90 per cent. per month of twenty-eight days have been recorded in the conditions of Table I.

It is not proposed to discuss in detail in the present paper the exact way in which the presence of entangled air increases the rate of attack; from a purely chemical point of view any very large increase would appear to be improbable, since it is the air in solution that is supposed to be the active chemical agent. It may be said, however, that the action is largely physical and has to do with the penetration and eventual removal of a scale on the metal which is normally protective; under certain conditions of aeration no effective scale is formed. For instance, there is a tendency of basic salts, and possibly of other corrosion products to arrange themselves round the air bubbles, *i.e.*, at the air-water surface instead of at the metal-water interface, and this must clearly interfere with scale formation on the metal. A reason why small bubbles are more harmful than larger ones is that the former tend to be retained in small eddies near the tube wall, especially in the neighbourhood of any obstruction, whereas larger bubbles have a greater tendency to travel along in the centre or on the top of the stream. The presence of small bubbles at the seat of corrosive action not only increases the rate of certain chemical changes, particularly that from cuprous chloride to cupric chloride and oxychloride (atacamite), but also prevents the formation of a protective film as indicated above. Accordingly one of the most remarkable characteristics of this type of action is the freedom of the corroded surface from corrosion products.

A high water speed increases the rate of action by forcing fine air bubbles into or through the normally protective scale.

Certain alloys, when subjected to the air-water jet test, have their surfaces beautifully etched. They become smooth enough and sufficiently free from corrosion products for microscopic study of the crystalline structure at moderate magnifications; others appear to have an almost polished appearance, especially those which have a "flowed" structure throughout the alloy. At first sight such alloys may seem to have been eroded mechanically rather than corroded, but there is much evidence against this view; the erosive action is confined to the products of corrosion only.

The reason for the peculiar distribution of the corrosion on tubes suffering from the rapid type of action described at the beginning of this article may now be suggested. It will be remembered that the position at which the action is usually worst is the first two or three feet of the tube at the inlet end. It is just at this position that turbulence and impingement of air on the tube wall are worst; here the tube suffers from an intermittent bombardment with air bubbles, as shown diagrammatically in Figs. 9 and 11. Further along the tube the turbulence dies out and corrosion falls off. The remarkable observation has been made, however, that the size of the bubbles gradually decreases, and towards the end of a long tube—*e.g.*, 15ft.—much of the air appears to be distributed as a fine "mist" of air in water, *i.e.*, in just the state in which it is most harmful. So fine is this mist that with an average speed of 7.5ft. per second through the tube no tendency for the bubbles to rise to the top of the tube could be seen. Any roughening of the tube surface by local scale accumulation or otherwise, or any obstruction in the tube will be liable to cause local eddies and local air bombardment, and consequently give a chance for corrosion to start. The matter is illustrated in Figs. 12 to 15.

Enough has now been said to show that if air is present in fine bubbles or as a foam in a rapidly flowing stream of sea water the rate of corrosion will be greatly increased as compared with similar stagnant water or water flowing at the same speed but free from entangled air. The question now arises as to whether such air is actually present in condenser circulating water in ordinary conditions of practice, and, if so, how it gets there.

Unfortunately, in many cases, especially in marine practice, it has not been possible to determine by actual inspection whether or not such air was present. In a few cases in power station practice it has been possible to observe the outlet water stream from the condensers; in all cases so far examined there has been a close correspondence between the speed and type of corrosion of new tubes and the presence of entangled air.

As regards the source of entangled air in circulating water much will depend on the particular conditions of a plant. In marine practice it may be suggested that entangled air would normally be present whenever the ship was in motion, and especially in rough weather. Leaks in the pipe line are probably of comparatively small importance, as the inlet train would

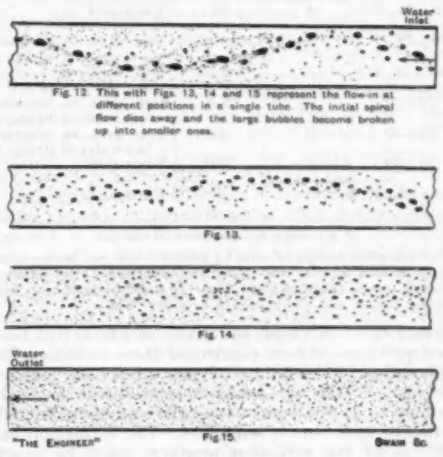



Fig. 12. This with Figs. 13, 14 and 15 represent the flow-in at different positions in a single tube. The initial spiral flow dies away and the large bubbles become broken up into smaller ones.

Fig. 13.

Fig. 14.

Fig. 15.

FIGS. 12 TO 15

probably be at or about atmospheric pressure. In many land plants, on the other hand, the condensers are frequently near the top of a siphon, the circulating water being sucked up many feet. In such cases a considerable portion of the inlet pipe train will be below atmospheric pressure and air will be drawn in at any loose joint. Thus the presence of a loose bolt and nut may cause corrosion of a new tube. Air leaks of considerable size can be detected by the accompanying hissing sound or by the use of a lighted taper, but small leaks may pass unnoticed for long periods and cause much trouble. The actual arrangement of the pipe trains and the tightness or otherwise of valves and gates will sometimes account for the irregular distribution of corrosion amongst the condensers of a single plant.

If it be true that entangled air is usually present in marine conditions, and often in power station practice, it would seem at first sight that rapid corrosion and failure of tubes should be much more common than it is. Even in modern conditions, however, serious corrosion troubles are only met with in a small proportion of marine and power station plants, though when they occur they may be very serious. Moreover, severe corrosion usually occurs in the early life of a tube, whereas entangled air may possibly be present during the greater part or even the whole of its life. How is it, then, that so many tubes successfully stand up to conditions that would appear to be corrosive on the views given above.

One reason for this is that entangled air often passes by preference through a comparatively small number of the tubes in a condenser, and the swirling in the water ends will probably decide which. Such swirling will be determined partly by the arrangement of inlet piping and water ends, and partly by obstructions such as steel protective blocks, &c., in the water ends (*cf.* Fig. 7).

This reasoning, however, does not account for the special liability of tubes to fail when new; for this a totally different explanation must be sought.

* Varying the angle down to 45 deg. had but little effect on the result.

The explanation is that tubes can, in certain conditions, coat themselves with a scale consisting largely of corrosion products which will resist the attack of an air water stream. This suggestion is in harmony with a great number of observations that have been made on the general nature of corrosive action on copper and its alloys. Thus the rate of corrosion in stagnant water has been found to fall off with time, a fact that is readily explained by the gradual accumulation of scale on the metal. In fact, the conclusion has been drawn from a large amount of experimental work that the chemical stability of most of the common industrial metals and alloys in water is mainly dependent on the protective properties of the scale which forms on them, and that local pitting of the metal is due to local failure of the protective properties of the scale. Such failures may be brought about by either chemical or mechanical causes, or by both together.

If a tube of Admiralty alloy or 70 : 30 brass be kept immersed in stagnant sea water at 40 deg. Cent. for a week and then be removed, dried, and submitted to the air water jet test it will be found that its resistance has been greatly raised, as compared with that of the same tube tested without the preliminary treatment. Some comparative figures are shown in Table II

TABLE II.

Time of experiment .. .. .. 28 days
Temperature .. .. .. .. .. 20 deg. Cent.
Speed of water .. .. .. .. 10ft. per second
All tubes tested without drying of scale previous to test.

| Alloy. | Maker. | Per cent. penetrat'n on 1.21 cm. 18 W.G. | Treatment before test. |
|---|---|---|---|
| 70 : 29 : 1 | A | Less than 1 | One week in stagnant sea water at 20 deg. C. |
| 70 : 28.5 : 1.5 | A | 4 | One week in stagnant sea water at 20 deg. C. |
| 70 : 30 | B | 8 | One week in stagnant sea water at 20 deg. C. |
| 70 : 30 | C | 36 | One week in stagnant sea water at 20 deg. C. |
| 70 : 30 | Average of six makers | 30* | Untreated |
| 70 : 29 : 1 | A | 35 | Untreated |
| 70 : 29 : 1 | A | Less than 1 | One week in stagnant sea water at 40 deg. C. |
| 70 : 28.5 : 1.5 | A | 2.5 | One week in stagnant sea water at 40 deg. C. |
| 70 : 30 | B | 2.5 | One week in stagnant sea water at 40 deg. C. |
| 70 : 30 | C | 43 | One week in stagnant sea water at 40 deg. C. |
| 70 : 30 | Average of six makers | 30* | Untreated |
| 70 : 29 : 1 | A | 35 | Untreated |

* Extreme figures were 26 and 33.

The complete failure of tube by maker C will not be discussed in this article, as it is due to an unusual cause ; the result is included in the table to show that the conditions of test were actually severe and would attack a faulty tube.

Further tests on tubes, the scales of which had been dried previous to test, confirmed these results. The explanation of the failure of new tubes now becomes obvious. If the air water bombardment is to be strongly corrosive it must take place on metal entirely or nearly free from a sea scale. The formation and removal of the corrosion products must be nearly simultaneous ; scale formation must not get decidedly ahead of scale removal if very rapid action is to take place. A sea scale, however, does not necessarily protect a faulty tube.

No doubt in time an air water attack will work through a scale formed on a tube in ordinary conditions of practice and cause corrosion beneath it, but the action, though more rapid than that of an unaerated water stream, will not be nearly so rapid as that on a new tube since there is always an intervening layer of scale hindering the action, and this layer once formed fairly thickly does not appear to be removed completely. Consequently, if during the early life of a tube in a condenser water is only slowly circulated and contains little or no entangled air, scale formation will get ahead of scale erosion and the tube may have a long life. In ships' condensers a slow circulation of water while in dock or a builder's yard when there is no motion of the ship may build up a good protective scale.

The experiments on scales described above were mainly carried out with scales formed at a temperature of 40 deg. Cent. It has been found that such a scale is decidedly more protective than one formed at ordinary atmospheric temperatures, though the latter has some protective value. It is interesting to note that as far as the corrosion of 70 : 30 and Admiralty brass tubes are concerned the increase of vacuum—and corresponding lowering of temperature—which has occurred in modern condenser practice has had a decidedly adverse effect on corrosion. The contrary is true of arsenical copper tubes ; such tubes are more rapidly corroded at 50 deg. Cent. than at 20 deg. Cent.

### PREVENTION.

It is now necessary to consider what measures can be taken to prevent the rapid type of corrosion described in this paper. On the general principle that prevention is better than cure, the simplest plan would seem to be to eliminate the entangled air from the circulating water. This is, no doubt, a simpler matter than the removal of the dissolved air, but in view of the immense volumes of water used in condensers it presents many difficulties. In marine conditions it would seem to be almost impossible. In power station practice something can be done to prevent air from becoming entangled in the water by attention to leaks in the pipe lines where they are below atmospheric pressure, and other measures may suggest themselves as locally suitable. In this connection it would be an advantage if means could be provided for the inspection of the outlet water so that the presence of air could be definitely ascertained.

If air once gets into the water stream it is very difficult to eliminate it by a settling process. The large bubbles can easily be removed, but the small bubbles only leave the stream slowly, and these are just the bubbles that are so harmful. Effective removal of these would probably require a large and costly apparatus, which would be commercially impracticable.

It would be a great advantage if records were kept of the *exact* positions and times of all tube failures in condensers. For this purpose it is convenient to use a large plan of the tube plate and mark off each tube on it when it fails. In many cases this would delimit the bad areas and prevent unnecessary re-tubing of whole condensers—a procedure occasionally carried out after a few failures on the assumption that the tubes are at fault and would, therefore, fail throughout the condenser. The authors' experience shows that many good tubes have been unnecessarily scrapped in this way. Remedial measures need only be applied to the affected areas in such cases ; the rest of the tubes can safely be left in the condenser.

A simple method of reducing the trouble has already been suggested, namely, to use for replacements Admiralty tubes that have been heated to 40 deg. Cent for a week in sea water, which should be stagnant or only slowly moving. If this cannot be done then tubes from other parts of the condenser in which failures are known to be few should be used for replacements, and new tubes inserted in the positions thus vacated. This procedure will often require tubes to be moved from the second pass to the first in two-pass condensers, and will be most effective if proper records of failures are kept.

It is perhaps desirable to emphasise that only one type of corrosion has been discussed in this article. Other types, quite different in origin, and requiring different remedial measures, also occur in practice. As an instance, so-called "dezincification" may be noted. Ten years ago the latter was the more important type, but owing to the increase in condensing efficiency with the consequent lowering of condenser temperatures and the increase of water speed, it is now of less importance than the type discussed in this article.

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## International Navigation Congress.

No. I.

IT is a somewhat remarkable fact that although navigation conferences have been held at irregular intervals over a number of years—the first having been held at Brussels in the year 1885, and the last in Philadelphia in 1912—there has not, until now, been a meeting in London, the world's greatest centre of maritime communication, although a congress dealing with inland waterways questions, to which the subjects of earlier gatherings were confined, was held in Manchester in the year 1890. At last, however, London is the place of meeting, and the Congress which has been in progress during the present week, and the sittings of which terminate to-day, has proved an unqualified success.

The Congress was convened by the Permanent International Association of Navigation Congresses—one of the several international bodies having headquarters at Brussels. It came into existence in the year 1902 as a result of congresses on inland and maritime navigation and the utilisation of rivers which had been held in various European cities between 1885 and 1898. The object of the Association is to promote the progress of maritime and inland navigation, and it accomplishes this object, as in the case of similar associations which have been formed to promote the development of railway and road transport, by the publication of reports dealing with experience in works for navigation and in the design and construction of ships in all countries and by the holding of congresses.

This week's Congress, of which Lord Desborough is President and Sir Maurice Fitzmaurice Vice-president, has attracted a large attendance, no fewer than twenty-eight foreign Governments having appointed delegates, while official representatives have been in attendance from the Governments of India, South Africa, New Zealand. Delegates have also been present representing the principal dock and harbour authorities, canal undertakings shipping companies, and in their individual capacity, engineers have come from many parts of the world.

There was an excellent attendance when the Congress was formally opened by the Duke of York in the Great Hall of the Institution of Civil Engineers on Monday morning last. The Duke said that he desired to offer a welcome to delegates on behalf of the King, who was patron of the Congress, and who would look forward with interest to the result of its deliberations. The international character of the Congress made the occasion important, and the fact that there were delegates from so many foreign countries and our own Dominions was proof that such a Conference was to the interest and advantage of every nation. Although the subjects to be discussed were largely of a technical nature, it was easy to realise that navigation, whether ocean or inland, was a factor which vitally concerned every country, because the exchange of goods of all kinds was, to a large extent, carried on on the sea. In these difficult times any meetings which enabled individuals of different countries to get to know one another and to understand one another must be of the greatest value to the world at large.

### A REPRESENTATIVE GATHERING.

Lord Desborough said that it was a great gratification that the invitation extended by the British Government to the Governments of the countries supporting the Permanent Association was accepted by so many foreign Governments, and he cordially welcomed the presence in London of the many distinguished men appointed as their representatives. They had been called together for the purpose of promoting and advancing the progress of inland and maritime navigation. Some of the advances made through the work of the International Association might be mentioned. The discussions at the Vienna Congress of 1886 served as the basis for the studies of the cross sections to be adopted for the whole of the canals of Central Europe. The transformation of the Erie Canal for 2000-ton boats was inspired by the ideas developed at that Congress. The construction of locks to overcome great differences of level and of lifts for boats were considerably advanced as a result of the same Congress. The question of the protection of the banks of canals and rivers had been thoroughly studied. The experiments necessary to determine the shape of boats and the cross sections of canals so as to reduce the efforts of traction to a minimum were also carried out on the suggestion of previous Congresses. The Congresses had also been the means of bringing about great improvements in high-powered dredging appliances and in the machinery used for construction. Monsieur Dufourny, a past-President of the Association, whose recent death was a great loss, had put upon record his opinion of the work which had been done. He had claimed that in the course of a few years the International Association of Navigation Congresses had passed in review so well and so completely the domain of hydraulics and navigation that there existed in this domain a universal science and a doctrine which served for the whole world as the basis for modern technical teaching. Local opinions and theories founded on narrow and circumscribed data had given place to a general science which the world-wide contributions to the art of the civil engineer had done so much to form. In addition to the presentation of reports and discussions, which it was hoped would hasten the time when definite pronouncements might be made on various subjects of interests, the British Organising Committee had arranged for a series of visits to British docks and harbours. Those from abroad who travelled through Great Britain on these visits would discover that the natural features of the country did not permit of the construction of those magnificent waterways which were a feature of the continental transport system. British rivers were small, and since no part of the country was far from the sea, we were as a people less dependent than other countries on inland navigation. The sea itself was our great canal.

### OCEAN TRANSPORT PROBLEMS.

Sir Ernest Glover, in a presidential address to the Ocean Navigation Section, said that to Great Britain it was a truism that cheap and efficient ocean transport was a vital necessity. England was dependent on sea carriage for the importation of the greater part of her food and of the raw materials for manufactures, as well as for the export of the coal and manufactured goods which formed part of the payment for the imports. He noted that the "use of liquid fuel for navigation and its consequences" was to be the subject of a communication to the Section. In this connection it was of interest to see that the weight of the oil imported in 1922 exceeded that of any other raw material—iron ore coming second. It was of interest to review some of the factors which had made sea transport cheap and efficient. Steamers must be up to date, utilising the most modern improvements in design ; they must be of the size best fitted for their particular trade and engined so as to be most economical in the use of fuel and of labour. There was always a conflict between economy of operation and speed. For a cargo vessel high speed was of secondary importance compared with lowness of running cost and consequent lowness of freight. The passenger was usually willing to pay more for his passage in proportion to the reduction of its

duration and he preferred the large ship. Perishable cargoes frequently required high speeds, as otherwise the cost of refrigeration for the long voyage was unduly increased. A second conflict was that between the most suitable size of ship and the accommodation provided by the likely ports of call, or by canals of which use had to be made to reach the destination. Passenger ships on the Atlantic route had developed to a size impracticable on the Suez Canal route to Australia and the East, and were strictly limited in the choice of their terminal ports. Any attempt to develop other ports for their accommodation would probably be entirely uneconomic. The chief economies from the use of oil fuel were in the time saved in bunkering and the labour saved in the stokehold and in the more even production of steam. The subjects to which the Congress was asked to devote most attention were the relative advantages of ship equipment and port equipment for loading and discharging ships—mechanical equipment of ports, mechanical handling of cargoes—loading, discharging and carrying between ships and shore, and so forth. The provision of increased accommodation and the improved facilities at the ports involved heavy capital expenditure, with consequent charges for interest and sinking fund, as well as repairs and maintenance, leading to a heavy daily charge for standing expenses. These were necessarily reflected in dues on ships and cargoes, and the question, therefore, arose in most ports as to how far such expense would be justifiable by the increased facilities obtained—whether the increased rapidity in the handling of cargoes and in bunkering would prove an economy commensurate with the capital expenditure involved. With regard to coal exports particularly, the continuity of loading was of the utmost importance, and for that reason the re-introduction of the three-shift system at the ports on the North-East Coast, and more recently at South Wales ports, was very welcome. The rapidity of loading coal was almost entirely dependent on the shore equipment, and British ports suffered from the smallness of the traditional coal wagon, 8 to 10 tons, as compared with 20 tons or 25 tons or even 40 tons on American railways, whilst tips and cranes were in many cases antiquated and defective, and railway arrangements for the handling of the trucks frequently left much to be desired. Turning to the problem of accommodation—the depth of basins—the width of entrances—and the lengths of quays—all matters seriously affecting the capital expenditure and the consequential burden of standing charges, it was necessary to face the question whether these should be given preference as compared with the provision of extra facilities for rapid loading and discharging. Size was a matter that particularly affected passenger ships. Tramps, which did so great a part of the carrying trade of the world, were necessarily limited in size by shipping possibilities, which in various parts of the world were controlled by natural bars or by the port being situated on a river where draught of water could not be increased. Another point to be borne in mind was to see that where improved facilities for the actual loading and discharging of cargoes were to be provided, corresponding improvements were possible in the arrangements for sending goods forward for shipment, and in their distribution from the point at which the steamer discharged.

### THE DIMENSIONS OF PORT WORKS.

The first subjects taken before the Ocean Navigation Section were those embodied in the reports dealing with the accommodation to be provided for ships at ports to satisfy the growth in the size of ships, and the types of works which should be undertaken for berthing ships of great draught in tidal seas. The two subjects are so intimately associated that the reports, to some extent, overlap. The general reporters are Mr. L. H. Savile and Mr. H. H. Wilson.

The reports dealing with new works at ports are seventeen in number. Five of them deal with the present and probable future dimensions of ships, eight with the accommodation to be provided at docks, and the remainder with new works.

Sir Cyril R S. Kirkpatrick, M. Inst. C.E., the engineer-in-chief of the Port of London Authority, repeats the opinion to which he gave expression at the 1921 Engineering Conference, that for an entrance lock to a dock intended for the largest ships, dimensions not less than those suggested by Dr. Corthell, namely, 1100ft. (335 m.) long, 130ft. (40 m.) broad and 45ft. deep, should be adopted, and he still considers that vessels 1100ft. in length will be constructed, requiring an entrance as defined above, the depth on the sill of 45ft. (13.7 m.) being measured from the lowest predicted neap tide. It is suggested that while a vessel of this size will be mainly used for passenger traffic, the dock required can be used for a cargo carrier of considerably less length but of economic breadth and draught.

He recommends that the length and breadth of dry docks should be similar to that of the entrance locks, and it is suggested as doubtful whether the sill should be constructed at any higher level, while in any case the floor should be 4ft. below the sill to allow of carrying out repairs. For wet docks a depth of 45ft. (13.7 m.), with a silting margin as may be found necessary, is proposed, but the width is determined by the number and type of craft required for loading and discharging purposes, and it is suggested that if land is not too expensive it is safer to err on the wide rather than the narrow side. A width of 150ft. (45 m.) for transit sheds and 40ft. (12 m.) quay space is proposed as being the most economical and suitable, and the question of cranes is dealt with in very considerable detail.

Attention is drawn to the fact that in some modern vessels the bridge deck projects several feet beyond the beam, and it is suggested that naval architects might consider the practicability of avoiding this projection.

Mr. L. H. Savile, M. Inst. C.E., Civil Engineer-in-Chief to the Admiralty Works Department, London, has prepared estimates for three sets of seven harbours supposed to be constructed in three typical classes of material. One set in silt, one in clay, and the third set in silt and clay overlying rock. The harbours in any one set are graduated as to depths at increments of 5ft. between the limits of 22ft. and 52ft., and are intended to be suitable for ships of draughts varying at equal increments from 20ft. to 50ft. The estimates indicate an increase in cost approximately proportional to the ratios of the cubes of the draught. Particulars in respect to the saving which may be effected by employing only ships of economic draught are given in the report, and it is deduced that with a saving of 1s. per ton on cargo due to the employment of these economic ships the deepening of a harbour cannot be justified unless the annual tonnage to the port exceeds by more than 60 per cent. the cost in pounds sterling of deepening the harbour.

Sir John Biles, M. Inst. C.E., treats the question from a different standpoint, *i.e.*, the determination of the sizes of the ships in which goods may be transported over a given total sea distance at the lowest transportation cost per ton per mile.

It is shown that five factors enter into the question of economic transportation: (1) Length of voyage; (2) speed of ship; (3) size of ship; (4) rate of handling cargo; (5) transportation rate, besides several "secondary" variables both of construction and operation.

Mr. Foster King refers to his former paper read at the Philadelphia Congress furnishing statistics as to the growth of ships for the seventy years prior 1911. The present paper brings the information up to date.

He concludes that no ports which hope to handle the larger classes of ships in general service should be content with their efforts, unless they provide for draughts which exceed Suez Canal development or something of the order of 40ft. draught, within the next quarter of a century.

The following general conclusions were put forward for the consideration of the Congress:—That although the total number of ships in the world of 1000 tons and upwards has remained nearly constant in recent years there is and will continue to be an increase in the average tonnage, more especially in ships of from 5000 to 8000 tons, but it is unlikely that there will be any great increase in the size of the largest pre-war ships in the near future. That small vessels of 1000 tons and under still number about 50 per cent. of the total number of all ships, and will for an indefinite time have to be reckoned with in the consideration of port requirements. There is a tendency for economic reasons connected with the cost of running ships, for a general increase in the draught of large ships. The percentage number of vessels of 30ft. draught and over is at present very small, but is increasing, and there is little doubt that when the Suez Canal is deepened to 40ft. the percentage of ships above 30ft. draught will be greatly increased and first-class ports would do well to afford a depth in their approach channels not much inferior to that of the Suez Canal. Similar remarks apply to ports served by the Panama Canal, which already has a depth of 40ft. It is generally agreed that the cost of freight decreases as the size of ship increases. The variation of economic length with rate of handling cargo is greater the higher the speed, and for a given speed is greater for the longer voyage, while the effect of detention in port is greater for the shorter voyage.

The present depths in existing harbours and approach channels will set an ever increasing check on further draught of ships by reason of the greatly increasing cost involved in construction and maintenance of deeper harbours, and it is doubtful if this factor has been sufficiently allowed for in the prediction of the largest passenger ship dimensions in some of the reports. The difficulties of finding full cargoes, for very large vessels, and the enormous terminal sheds involved in collecting and distributing these cargoes will set a check on increased dimensions of abnormally large cargo carriers, as, apart from passenger ships, there is no probability of the trade of the world being eventually carried only in ships of large dimensions. There is a consensus of opinion that increase of draught in all passenger and passenger-cargo ships, and indeed in all high speed ships, has special claims on economic grounds on the cost of running ships, but this claim should be re-examined on the basis of total outlay involved both on ships and harbours. The equipment of a port in all labour-saving devices and adequate railway connections for the economic collection and delivery of cargo as well as for the rapid and cheap loading and unloading of vessels are of no less importance than berthing accommodation for ships. A first-class passenger harbour serving the Atlantic trade will require to provide a depth in the neighbourhood of 40ft. at L.W.O.S.T. A first-class harbour receiving the largest cargo-passenger ships should provide 35ft. at L.W.O.S.T. at a few tidal berths, with the possibility of deepening these to 40ft. in the future. There is a consensus of opinion in favour of the width from cope of wharf wall to sheds of 35ft. or possibly of 40ft. in certain places.

Figures quoted show the estimated cost of any one harbour of a series of harbours of different depths, each suitable for a given number of vessels of the same draught, to vary approximately as the cube of the draught. Further, as the trade of a port is largely carried in moderate-sized ships and only a very small proportion is carried in ships of extreme draught, the harbour dues obtained from the latter vessels are quite inadequate on the present basis of charges to pay for the extra cost of the necessary works involved by these few vessels of extreme draught. The absence of co-ordination between shipbuilders and shipowners and dock authorities in dock construction is pointed out as a serious defect in port development in the past, and it is suggested that a permanent committee representing all the various interests would be the best means for inaugurating a line of action that should have the effect of preventing the unnecessary expenditure of large sums of money in future construction.

### LIMITING SIZE OF SHIPS.

Professor Luiggi (Italy) said that the tendency was to make cargo boats bigger. The largest of the passenger ships was one of over 50,000 tons, and he did not think there would be any increase in size in the immediate future, as these very large ships were in the nature of white elephants. The favourite type of passenger ship in the immediate future would be a vessel of from 20,000 tons to 25,000 tons, with an absolute maximum of 30,000 tons to 35,000 tons. The normal type of cargo boat would probably be from 8000 to 10,000 tons, with a maximum for special requirements of 15,000 tons. It was desirable that shipowners and shipbuilders should come to an understanding that for the next thirty years limits of this character should be fixed. That would simplify the task which confronted harbour authorities. With regard to depth, it was desirable that the limit of draught should be fixed at from 28ft. to 32ft., which, allowing for a depth of 3ft. under the keel, would not impose upon dock owners the need to provide a greater depth than 35ft.

M. Edouard Quellennec (Consulting Engineer of Suez Canal Company) dealt at some length with the growth in the dimensions of ships. The attention of the Suez Canal Company had, he said, naturally been given to this question, and very careful statistics of the traffic using the canal had been compiled. It was shown that the average tonnage of ships using the Canal had increased from 4410 tons in 1900 to 6585 tons in 1922. Only a small percentage of Suez Canal traffic was in big ships, and those exceeding 16,000 tons did not form more than 3 per cent. of the total. The dimension of the waterway had kept pace with the growth in the size of ships. In 1902 provision had been made for a draught of 26ft, and in 1922 for vessels drawing 31ft. One of the largest ships which had made the passage of the Canal was the Amerika. There were only fourteen ships in the world larger than that vessel, and eight of them had been built for the special needs of the North Atlantic passenger trade and would never trade with Far Eastern ports. The Suez Canal management was determined to provide for all traffic developments. The programme sanctioned in 1912 by the Commission was to provide accommodation for ships of 28,000 tons with a draught of 33ft., and this programme would have been completed by this time but for the interruption caused by the war, but it would be completed by next year. Consideration had, however, been given to the need of providing for a further increase in the size of ships, and in the new programme which had now been authorised, and which would take six to eight years to complete, provision would be made for the use of the Canal by ships of 36,000 tons and 35ft. draught. To meet this growth in the dimensions of the vessels using the waterway it had been decided to deepen the Canal to 43ft.

Mr. A. H. Roberts (Leith) pointed out that in all cases local conditions had to be taken into account, and width of quay walls and equipment must depend on the character of the traffic. Some ports had a large percentage of traffic which was put on rail; others delivered a large tonnage to road motors; and a third case was where a considerable percentage of the cargo landed went into warehouse. At Leith it had been found desirable to have three railway tracks on the front of the quay, behind these tracks a broad shed, and two tracks in the rear of the shed. Some ports were hampered by the failure to link up quays with the railway system. A governing consideration in the whole matter was the rate of intensity of cargo discharge. It had been suggested that vessels of deep draught should pay increased dues to meet the capital cost of deepening docks and harbours, but the shipowner retorted that such vessels paid quite enough to dock authorities by reason of the fact that they brought very large cargo tonnages into port.

With regard to providing accommodation for big ships, he thought that a single port situated preferentially on the west coast should be made the centre of that traffic, although he had no hope that such a plan would be adopted. The scheme of co-operation between shipowners, shipbuilders, and dock authorities which was advocated in Mr. Savile's report was, however, quite practical, but he would suggest that stevedore and railway interests should be represented on a permanent committee of that character.

Sir Westcott Abell referred to the probable increase in the size of ships. He thought the tendency for the next four or five years would be to keep down the length of ships and to restrict the draught in accordance with the depth available at ports. He hoped that the whole question of size of ship and port accommodation would be considered from the national standpoint.

Mr. M. J. Watkins (Belfast) thought it would be inadvisable to tie dock and harbour authorities to any crystallised type of construction—the idea was perhaps only to lay down general principles.

Mr. F. E. Wentworth-Sheilds (Southampton) thought some of the conclusions stated in the report were obvious. Regarding the attempt to impose a limit on the size of ships, those who, like himself, had to deal with conditions at a port frequented by the largest liners were most anxious to know if the shipowner and shipbuilder, who had already produced the 50,000-ton ship, would eventually produce ships of 60,000 tons 70,000 tons, and 80,000 tons. Those responsible for the big ship harbours wanted to get together and fix a limit of size for the ship of the future. Mr. Savile had quite properly pointed out that the question was likely to be decided, not by the shipowner or shipbuilder, but by the dock owner, who would definitely say that he could not take a larger ship unless the shipowner was prepared to pay an increased rate per ton for dock accommodation. To accommodate a ship drawing 40ft. of water cost £200,000 per berth, and to accommodate a 50ft. ship would cost double that amount per berth. Mr. Savile had said the cost per berth would increase as the cube of the draught of the vessel to be accommodated. Could the engineer devise some means of cheapening the cost of construction? One or two suggestive ideas on that point had been laid before the Congress in reports. Mr. Gilbert had reminded them that recourse had been had in Ireland to timber for construction purposes, and that had led to a reduction in cost. There was the question how long the timber quay was likely to last, and it could only be answered by the test of experience in particular cases. If the engineers in that Congress could get together it might be possible to devise cheaper means of dock construction. There was another point. Cargo could not be got more rapidly out of a large ship than a small one, and a port to which large ships traded could not handle more cargo per foot run of quay per annum than a port frequented by smaller ships. That was one of the reasons why, although the shipowner might increase his earnings by putting into service large ships of deep draught, the dock owner was handicapped.

Captain F. Chambers (United States) said that he had just received a communication from the American Association of Port Authorities to the effect that he, Dr. Brysson Cunningham. and Mr. Swan, of Montreal, had been appointed as a committee charged with the work of investigating and reporting to a meeting of the Association at New Orleans in December next on the following points:—(1) The need of bringing about a greater degree of co-ordination between those responsible for the development of ports to determine the economies which could be effected by greater co-ordination in port design and equipment; (2) to ascertain by communication with the principal port authorities of the world how far this co-operation could be brought about and the means by which it could be secured. This subject appeared to be very closely related to the question under discussion by the Congress, and he desired to take that opportunity of bringing it before their notice.

Sir Ernest Glover thought a preferable plan would be for the committee referred to by Captain Chambers to make its report to the American Association, and to take steps that the report should be communicated to the Permanent International Association of Navigation Congresses, which would doubtless take steps to approach its members on the subject with the object of promoting a discussion at the next International Congress.

### Resolutions Adopted.

After further discussion the Congress unanimously adopted the following resolutions on the reports of Mr. Savile and Mr. Wilson:—

The thirteenth International Navigation Congress having read and discussed the reports dealing with the first and second questions adopted the following conclusions:—

That with regard to the probable future dimensions of ships, there is a tendency for economic reasons, connected only with the cost of running, for a general increase in the draught, but that although the percentage of ships drawing 30ft. and over is likely to be greater, this increase will be limited by the facilities offered by the main canal routes and principal harbours of the world, which should tend to check this increase in draught.

That there will be an increase in the average tonnage, more especially to ships of from 5000 tons to 8000 tons, but not in the tonnage of the largest pre-war ship in the very near future.

That the accommodation to be provided for ships should be guided by the consideration of true economy, and that against any anticipated saving in the cost of running a ship due to increase in draught, the additional expenditure entailed at all ports at which such vessels will trade, entailing the necessary deepening of approach channels, berths, dock and wharf walls, locks, dry docks, &c., must be taken into account, it having been shown that the cost of the provision of these facilities due to increased draught varies approximately as the cube of the depth.

That the provision of facilities for the rapid and economical despatch of goods on arrival at a port is as important as the provision of deep-water quays, &c., as the cost of collecting and handling goods in the large sheds and wide quays necessary to fill large ships to insure quick dispatch is an important item in cost. It may be useful in connection with an inland port situated at a great distance from the sea to construct a port of call for ocean liners near the coast under the same administration as the inland port.

That with regard to new and recently constructed work it is noticed that in certain instances 40ft. of water has been provided for Atlantic liners. The depth provided for cargo vessels generally has been much more modest, and it is considered that as the trade of a port is and will continue to be largely dealt with in ships of moderate draught, the deep draught ship should pay proportionately greater harbour dues.

That except for the Atlantic passenger service it is considered that when everything is taken into account, it will be difficult to justify the necessity for a depth of water at the quay side of more than 33ft. at L.W.O.S.T. for many years to come, while a port providing 30ft. of water at L.W.O.S.T. should be considered a first-class port.

The Congress proposes that these questions Nos. 1 and 2 be referred to the next Congress, and that in the meantime each nation should make an exhaustive study of this subject by the representatives of the various interests concerned, namely, shipbuilders, shipowners, dock authorities, dock engineers, and railway administrators, and that it be an instruction to these committees to consider the question of establishing a system of research into the whole question of the economic dimensions of ships and docks, as the want of the co-ordination in the past seems to have prevented the development of ports and ships on economic lines.

### Inland Navigation Section.

Lord Desborough, in opening the proceedings at the Inland Navigation section, said that several important subjects were to be discussed by delegates that week. The one on the agenda for that day was the utilisation of waterways for the production of power, a subject which demanded the closest attention of engineers. Water supply, navigation, and the production of power from water resources were allied subjects, and should receive careful consideration in order that our water resources might be utilised for all purposes in the best interests of the community. He would point out that in the upper watershed of the Thames the springs in February last reached their normal level for the first time in four years.

### Waterways and Power Production.

The general report brought up by Sir John Purser Griffith summarised the reports received from the United States, France, England, Ireland, Sweden, and Czecho-Slovakia.

The United States are represented by Colonel William Kelly, Chief Engineer to the Federal Power Commission; France by Monsieur. L. Armand, Inspector-General of the Ponts et Chaussées; England by Messrs. Binnie, Meik, Twinberrow, Addenbrooke, and R. E. Hindmarsh; Italy by Sig. Annibale Palluchini; Sweden by Messrs. Sven E. Lubeck and Axel Ekwall; and Czecho-Slovakia by Messrs. J. Smetana, A. Pacak, and J. Till.

Colonel Kelly lays special stress on the question of control of water resources, and referring to the powers created under the Federal Water Powers Act, 1920, states that for many years Federal laws had been wholly unsuited to prevailing conditions. The rights granted were so insecure and the liabilities imposed so uncertain, that the development of the inexhaustible water power resources was largely blocked and recourse had to steam power. The flood of applications which followed the passage of the new Act are abundant evidence of the extent to which former legislation stood in the way of power development.

In the reports contributed by English engineers the chief point of interest is the problem of the generation of electrical energy by the ebb and flow of the tide, special reference being made to the tidal power of the river Severn estuary.

Mr. Binnie deals with the English problem under the three heads:—(1) Artificial canals; (2) canalised non-tidal rivers; and (3) navigable tidal rivers. He summarises his views as follows:—It is to be feared that there is little prospect of using the artificial canals in Great Britain for the production of power. On the subject of the utilisation of the tides, he reminds the Congress that Sir John Snell's committee recommended that the Board of Trade, in consultation with the Minister of Transport, should set up a special Technical Commission, consisting mainly of expert engineers and persons of scientific attainments, to investigate the possibility, from a commercial standpoint, of utilising the tides for power purposes.

The Water Power Resources of Ireland Sub-Committee reported as follows:—Proposals have from time to time been made for the utilisation of tidal power at Strangford Lough. We have been impressed by the possibility of obtaining power from this source, and are satisfied that ultimately the scarcity of coal and oil will lead to its use. The problem, however, embraces such varied branches of engineering knowledge that it must be examined by the most experienced engineers, representing the various problems involved.

Mr. Binnie takes the view that the problem will be allowed to rest until another period of panic in connection with power production arises.

Dealing with Irish rivers and canals, Sir John Griffith said that Ireland had the largest river, the Shannon, and the largest lake, Lough Neagh, in the British Isles. Recent investigation had given a complete vindication of the proposal to develop power by barrages and power stations erected along the course of the river. It would not be necessary to construct costly headraces or inlet canals; fishery interests would be preserved and facilities for navigation improved. Power could also be developed as the need arises.

The following conclusions are submitted for the consideration of the Congress:—

(1) That in view of the shortage of fuel and its increasing cost, it is necessary to develop water power wherever available.

(2) That this Congress, while primarily interested in problems associated with inland navigation, recognises the importance of combining navigable waterways with water power installations.

(3) That by such a combination cheap power is obtained, cheap industries are fostered, and cheap transport is provided, and that charges on capital are more easily met.

(4) That where possible the various interests in domestic water supply, navigation, water power, and fisheries should be co-ordinated, and works designed to combine and safeguard such interests.

(5) That in dealing with these problems no universal rule can be laid down, but that each case must be considered and treated on its merits.

(6) That for this reason it is desirable to have State control of the water resources of the country; and to establish an authority to allocate water for the various interests; with a service whose duty it should be to investigate proposed schemes, and formulate a policy for utilising in the best interests of the community the water resources of the country.

(7) That in regard to the utilisation of the tides for power purposes, the recommendations of the Water Power Resources Committees of Great Britain and Ireland are worthy of support, and that communications be invited on the subject for consideration at a future meeting of the International Navigation Congress.

## SIXTY YEARS AGO.

THE serious, not to say alarming, condition of boiler construction and management sixty years ago, is a striking feature to modern engineers revealed in our issue of July 3rd, 1863. At the monthly meeting of the Manchester Boiler Association it was reported that between May 29th and June 26th, nine boiler explosions had occurred, resulting in the deaths of eleven persons and in twenty-one cases of injury. Only one of these boilers was under the care of the Association. In the same period, the Association, during its inspections, had discovered nine boilers in a dangerous condition as a result of fracture, corrosion, over-pressure, &c., and had, in addition, found eight boilers without water gauges, and a like number without pressure gauges. Had the survey included but one day more—the 27th—it would, as indicated by a paragraph elsewhere in the same issue, have included a very serious explosion at Morley, whereby nine lives were lost. . . . Considerable attention was being devoted at the time to the merits of the small arms carried by our troops. The Government had recently spent three million pounds on equipping the Army with the Enfield .577 muzzle-loading rifle, but a committee appointed to inquire into the matter reported in 1863 that as regarded the form of rifling, the size of the bore and the method of loading, it was unsatisfactory. The committee strongly favoured the Whitworth .45 hexagonal bore rifle on account of the increased precision at long ranges achieved with it. The Government, however, hesitated to adopt the Whitworth rifle on an extensive scale on the ground that its merits had not been fully established, and that great confusion, if not disaster, would arise if war broke out while the change was being made. Against the adoption of the breech-loading principle, the view was urged that "the extreme facility of loading would induce the men to fire away their ammunition with too great rapidity." Eventually, it may be recorded, a committee of officers recommended, in 1864, the adoption of the breech-loading principle and following the triumph of the Prussians over the Austrians in 1866, the policy was adopted of converting the muzzle-loading Enfields into breech-loaders by cutting away the breech end of the barrel and inserting at that point a block fitted with a needle on the Snider principle.

## Railway Matters.

THE recent heat-wave experienced at New York temporarily put out of operation the electrically-operated lines of the New York Central. The insulation of the power cables melted and the third rail was distorted.

A SERVICE that truly deserves the name "cross country," to be brought into use on Monday, is from Liverpool, Lime-street, and Manchester, London-road, *viâ* Stoke, Nottingham and the Midland and Great Northern Joint Line to Yarmouth, Lowestoft, &c.

THE second reading of the London, Midland and Scottish Railway Company's Bill was agreed to on June 14, after Mr. Will Thorne had said that his opposition was withdrawn on the promise of the general manager that the electrification of the Tilbury section would be proceeded with at the earliest possible moment.

THE daylight service from England and Scotland to Ireland and *vice versa*, *viâ* Stranraer and Larne, will be re-opened on the 9th inst. after an interval of eight years. The service will be given by the 10 a.m. from Euston, due Belfast 11.5 p.m., and in the opposite direction passengers will leave Belfast at 9.5 a.m. and be due at Euston on the "afternoon corridor" at 10 p.m.

WHEN the Caledonian Railway Company's case came again before the Railway Amalgamation Tribunal, the chairman of the latter said that the Tribunal was not prepared to state a case for appeal on any point of law, but would proceed to seal the scheme. That was done on the 29th ult., and the Caledonian, also the North Staffordshire ceased to have any separate existence on the 30th.

AFTER a very full discussion between the South Wales General Committee of Traders and the Great Western Railway, an agreement was recently arrived at with the railway company whereby dock charges, including tonnage dues, wharfage and cranage, have been reduced from 75 to 60 per cent. above pre-war charges, and tipping and weighing charges from 8d. to 7½d. per ton. These reductions came into force on July 2nd.

THE Aberdeen–Penzance service by the East Coast route, introduced two year ago, is, from Monday, to have a competitor by the West Coast and Severn Tunnel route. The latter will leave Aberdeen at 12.30 p.m. and be due Penzance at 1.20 p.m. the next day. In the opposite direction it will leave Penzance at 12 noon and be due Aberdeen 7.52 a.m. The East Coast timings are: Aberdeen depart 9.50 a.m., Penzance, arrive 1.20 p.m. next day; Penzance depart 11 a.m., Aberdeen arrive 7.30 a.m.

WHEN a presentation was recently made by the Locomotive Engineers' and Carriage and Wagon Superintendents' Conference to Mr. A. J. Hill, the late chief mechanical engineer of the Great Eastern, reference was made to the good work done by Mr. Hill in connection with the specifications for the construction of privately owned wagons. In this task, Mr. Hill succeeded his predecessor, Mr. John Holden. The first specifications were begun as a result of the Penistone accident of January 1st, 1885.

THE following works have been authorised by the directors of the Great Western Railway Company:—Extensive additional siding accommodation for shipment coal traffic and empty coal wagons at Newport Docks, Cardiff Docks, Cadoxton and Rogerstone; doubling of Porthcawl Branch between Pyle and South Cornelly; additional siding accommodation at Llantrisant; improvements to station buildings at Trowbridge; installation of new weighbridges at seventeen different points, to deal with motor traffic.

AT 10 a.m. on Thursday morning a serious accident occurred at Diggle, between Huddersfield and Manchester, on the London, Midland and Scottish Railway. From the accounts available at the moment of going to press we gather that a passenger train from Leeds to Liverpool crashed at full speed into a light engine, with the result that the first and second coaches were telescoped. An official announcement issued at Manchester states that four passengers and two guards were killed, and about five passengers and two railway men injured.

IT was announced on page 652 of THE ENGINEER for June 22nd that terms have been arranged for the absorption of the Wirral Railway. These are considered to be very favourable to the latter and to have warranted the directors holding out. The loans will be taken over, the holders of the debentures and preference shares will receive London, Midland and Scottish securities yielding the same income as they now receive, and the holders of the £10 ordinary shares will receive half the face value of the shares in cash within a week of the approval of the scheme by the Amalgamation Tribunal. The Wirral Company will be at liberty to pay £3200 to the directors as compensation for loss of office.

THE fire which burnt out the Broad-street Station of the Pennsylvania Railroad at Pennsylvania on June 10th, was probably caused, according to an account in the *Engineering News-Record*, by faulty electric wiring. Wooden framing and decking covered with a waterproofing layer formed the track floor, being supported by a system of steel columns, floorbeams and stringers. Below the supporting steelwork were metal ceilings supported by wood framing, to cover the rooms below. The fire started in the space between floor and ceiling, according to present evidence, and got a thorough start by spreading in the long continuous open spaces under the track floor, where woodwork was exposed everywhere.

THAT railway charges for fruit, vegetables, agricultural produce, fish, &c., are higher relatively than they ought to be is a fallacy which has more than once been exposed in these pages. The assertion has, however, again been made by the Departmental Committee on Fruit and Vegetables in a report recently issued. The report mentioned broccoli from Cornwall as an item that illustrated the alleged excessive rail charges. The railway companies, in answer to this, show that a head of broccoli realises 6d., of which the railway company gets 0.35d. for carrying it 305 miles, the grower 1.01d., and the retailer 4.08d. The statement that the goods services are inferior to what they were in pre-war days has, in our opinion, about as much foundation as the allegations about the rates.

## Notes and Memoranda.

IN a short article on marine sounding by means of the hydrophone, in *Engineers and Engineering*, the author suggests that it may be possible to study the shifting bed of a river during flood and thus gain knowledge that will help in flood control work.

WE learn that a first experiment with spent shale from the Scottish oilfields at the Building Research Board's experimental station has produced a puzzolanic hydraulic cement of a tensile strength at three months' age greater than that required for Portland cement by the B.E.S.A. Standard Specification. The cement is said to be of a pleasant light red colour, and to be much harder than ordinary Portland cement.

NIAGARA FALLS, the greatest single source of water power in the United States, will transform more of its power into electrical energy with the aid of the two largest generators that have so far been built. These generators are being constructed by the General Electric Company, and they are to be installed on the American side of the Falls. Each will produce 87,000 horse-power. Each generator will weigh 700 tons, will stand 35ft. high, and will have a diameter of 35ft.

THE growth of water power developments in Canada has been striking. Total installed horse-power has grown from 975,000 to 2,974,000 since 1910, central station installation from 605,000 to 2,204,000 horse-power, and pulp and paper installation from 191,000 to 484,000 horse-power. Should the rate of installation since 1910 be maintained at its present rate there will be installed in 1925, 3,360,000 horse-power; in 1930, 4,110,000 horse-power; and in 1935, 4,800,000 horse-power; and in 1940, 5,600,000 horse-power. These forecasts of growth are considered conservative.

IT is reported that the 50,000-kilowatt generating set which C. A. Parsons and Co. are building for the new Crawford-avenue station of the Commonwealth Edison Company will consist of three turbines, a 14,500-kilowatt high-pressure element running at 1800 revolutions per minute, a 29,000-kilowatt intermediate turbine running at 1800 revolutions per minute, and a 6500-kilowatt low-pressure turbine running at 720 revolutions per minute. Each will have its separate generator, but the intermediate and low-pressure turbines will be arranged in tandem on the same bed-plate with the generators at either end.

THE river Mahaveliganga, Ceylon, is said to be capable at its minimum flow, without any provision for water storage, of developing over 70,000 electric horse-power at a point which, on a direct line, is only 12 miles from Peradeniya, 24 miles from Ambawela railway station, and 20 miles from Nanuoya. A point 1 mile below the above, about 30,000 horse-power can be obtained. At a spot 8 miles distant from Kandy, about 12,000 horse-power; at Ulapane another 15,000 horse-power. The Kotmalie-oya can be harnessed to give over 6000 horse-power; Aberdeen Falls, 10,000 horse-power; Laxapana Falls and Kitulgala Rapids, another 50,000 horse-power.

THE relative popularity of two types of oil engine in some parts of America is evident from the following extract from a paper, read before the Boston Society of Civil Engineers by Mr. G. S. Davison, President of the Gulf Refining Company. That organisation has 200 engines in use, with a total horse-power in excess of 15,000. One of these is of the Diesel type of 150 horse-power. All of the others are of the Hornsby-Akroyd type. The compression in the Diesel engine is thirty times; in the Hornsby-Akroyd from twenty times and downward. These engines are used principally in pumping oil through pipe lines. The station duty of the latter engines shows an average consumption of $^{6}/_{10}$ lb. of fuel per brake horse-power hour. Straight crude oil out of the pipe line is used. This oil generally is about 40 deg. Baumé. Theoretically it has about 19,850 B.Th.U.'s but in practice it will average about 18,400 B.Th.U.'s.

THE Chinese Government Bureau of Economic Information has published a sheet of tabulated information respecting cotton mills in China. One of the most important features is the column dealing with the motive power employed. Of the 112 mills in the list, 37 use electricity either wholly or in part, the remainder being apparently provided with steam plant. Practically all the establishments in Shanghai and Woosung—numbering 24—are electrified, and it will thus be seen that the opportunities for trade in this direction lie mainly in other parts of the Republic. Five British-owned mills are listed. These are all in Shanghai, but the motive power employed is not stated. Information in this respect is also lacking in the cases of 32 Japanese-owned factories, mainly in Shanghai and Tsingtau. Apart from these, however, there is a number of establishments with from 3000 to 90,000 spindles—average about 20,000—in which steam power is still employed.

AT the recent summer meeting of the Institution of Heating and Ventilating Engineers, at Folkestone, under the presidency of Mr. John Watson, Mr. J. Roger Preston, in an interesting paper, remarked that the cooling of air had been mostly carried out as a necessity in specialised industrial processes, either for the purpose of reducing the humidity by condensing part of the aqueous vapour, or for the production of low temperatures. The employment of the system in this country for the purpose of obtaining comfortable and healthy conditions in our buildings has been very limited, except to the extent of cooling the air within a few degrees of the initial wet-bulb temperature, with the usual air washer re-circulating the spray water. Modern physiological research tended to prove the necessity of keeping the wet-bulb temperature within narrow limits, say, from 54 deg. to 58 deg., if it was desired to ensure comfortable and healthy conditions. The paper dealt with the means of obtaining conditions approaching this ideal in a building, when it was hot and humid outside. It was in the memory of many that an ordinary air washer, for the purpose of cleansing the air, was considered to be a luxury and an expensive one. This, however, was now quite common, and they might see the day when an up-to-date heating and ventilating plant would not be considered in any way complete without a properly designed equipment for cooling and de-humidifying.

## Miscellanea.

THE Government of Ontario has established an ore sampling and testing laboratory at Cobalt, in Northern Ontario, where parcels of gold ore from 100 lb. upwards are sampled and assayed for prospectors.

ACCORDING to the *Ironmonger* a large plant, which will cost some £60,000, is to be put up at Seattle for the production of lead pipe, sheet lead, &c. It is allied with mines producing 50,000 tons of lead a year.

THE second of the South African Government all-lease mining areas—New States—commenced crushing early in May. The plant has been laid out on a basis of 600,000 tons per annum capacity, with provision for extension.

A WIRELESS direction-finding station will shortly be established by the Federal Government on the West Coast of Vancouver Island for the benefit of shipping. The latest type of apparatus, on the aperiodic aerial system, will be installed.

EXPERIMENTS with a view to utilising nickel-ore supplies from a recently discovered deposit in Alaska have been carried on at Seattle. An attempt is being made to devise a new method of treating the ore, which is a massive sulphide containing chalcopyrite, pyrrhotite and pentlandite.

THE first of the Committees of the Fuel Research Board has now been actively at work in the Lancashire and Cheshire area for nearly eighteen months, and the Board has recently appointed a Committee to deal with the survey in the South Yorkshire area. The South Yorkshire Coal Trade Association and the Midland Institute of Mining, Civil and Mechanical Engineers are co-operating in the work.

As we go to press we learn that three silver medals have been awarded in the new implement section at the Royal Agricultural Show. One to Wm. Foster and Co., Limited, Lincoln, for the threshing machine and stack feeder, which is illustated on page 18; one to Petters, Limited, Yeovil, for their cold-starting two-stroke oil engine; and another to John Wilder, Reading, and R. J. and H. Wilder, Wallingford, for their self-cleaning harrow pitch pole.

THE Sydney City Council, which recently decided to give absolute Empire preference in its electrical contracts for two years and shortly afterwards revised its policy to a 15 per cent. preference, is said to have again amended its attitude on the subject. The Council has decided that each tender shall be considered on its merits, and the degree of preference on Australian and British goods has been left to the discretion of the Council.

IT is stated by the General Export Association of Sweden that the total area of agricultural land in Sweden supplied with electric light and power facilities is now 1,500,000 hectares, or 40 per cent. of the grand total. The present consumption of electric current by the farms is 110,000,000 kilowatt-hours per year, the estimated consumption at complete electrification being 390,000,000 kilowatt-hours. All electric installations of the country are computed to be worth about 750,000,000 kronor, of which 250,000,000 kronor fall to the farming districts.

THE British Non-Ferrous Metals Research Association proposes to undertake the investigation of the alloys used in die casting. The research has been divided into: (1) Brass and bronze alloys; (2) aluminium alloys; and (3) low melting point alloys (zinc, tin, lead, &c.). These three branches will be dealt with in separate institutions, under the supervision of recognised leaders of metallurgical research, and every care is being taken in the constitution of the committee which controls the work, to ensure that both the manufacturers and the users are represented. Full particulars of the scheme can be obtained from the Association's Headquarters, 71, Temple-row, Birmingham.

ACCORDING to the Bureau of Statistics the number of automobiles manufactured in Canada during 1922 exceeded all previous records and reached a total of 101,007, or 7 per cent. more than the maximum production of former years attained in 1920, and 53 per cent. more than the output in 1921. The total value of the output was 81,956,429 dollars, or 14,906,220 dollars greater than in the preceding year, although 19,509,417 dollars lower than the corresponding figures for 1920. The advances were especially marked in the various sizes of closed cars. The output of *coupés* increased from 3276 in 1920 to 5367 in 1922, and of sedans from 4681 to 10,431. The number of runabouts also increased from 3759 in 1920 to 4700 in 1922. The production of touring cars was 58,596, or 8723 less than in 1920, but 13,786 greater than in 1921. The output of trucks followed a similar trend; 10,174 were manufactured in 1920; 5148 in 1921, and 8169 in 1922. The largely increased production was reflected in the employment records, the number of wage-earners employed rising from a monthly average of 4429 in the previous year to 6043 in 1922.

THE six new boilers of 325,000 lb. normal evaporation per hour each, which have been ordered by the Detroit Edison Company for installation, it is understood, at its Trenton Channel power station, are to be fired with "Lopulco" pulverised fuel. These boilers are, it is reported, to be of the "W" Stirling type and of 29,000 square feet heating surface. The equipment for the first section of the station is to consist of the six boilers and two 50,000-kilowatt General Electric turbines, and the working pressure is 425 lb. gauge with Babcock and Wilcox economisers. These boilers are intended to operate, usually, at about 300 per cent. American rating; that is, 300,150 lb. evaporation per hour, but are guaranteed to take 400 per cent. rating; that is, 400,200 lb. per hour for peak loads and emergencies. The Detroit Edison Company has made the most exhaustive investigations into the performance of the "Lopulco" installation at Lakeside, Milwaukee, as compared with its own plants with mechanical stokers, with corrections for the latest type of stoker that would be possible on a new plant. The net results are said to have shown an efficiency of 5 to 6 per cent. in favour of pulverised fuel, but an even more important point is stated to be that 400 per cent. rating can be operated without difficulty, whereas with mechanical stokers the figure is only 285 to 300 per cent.

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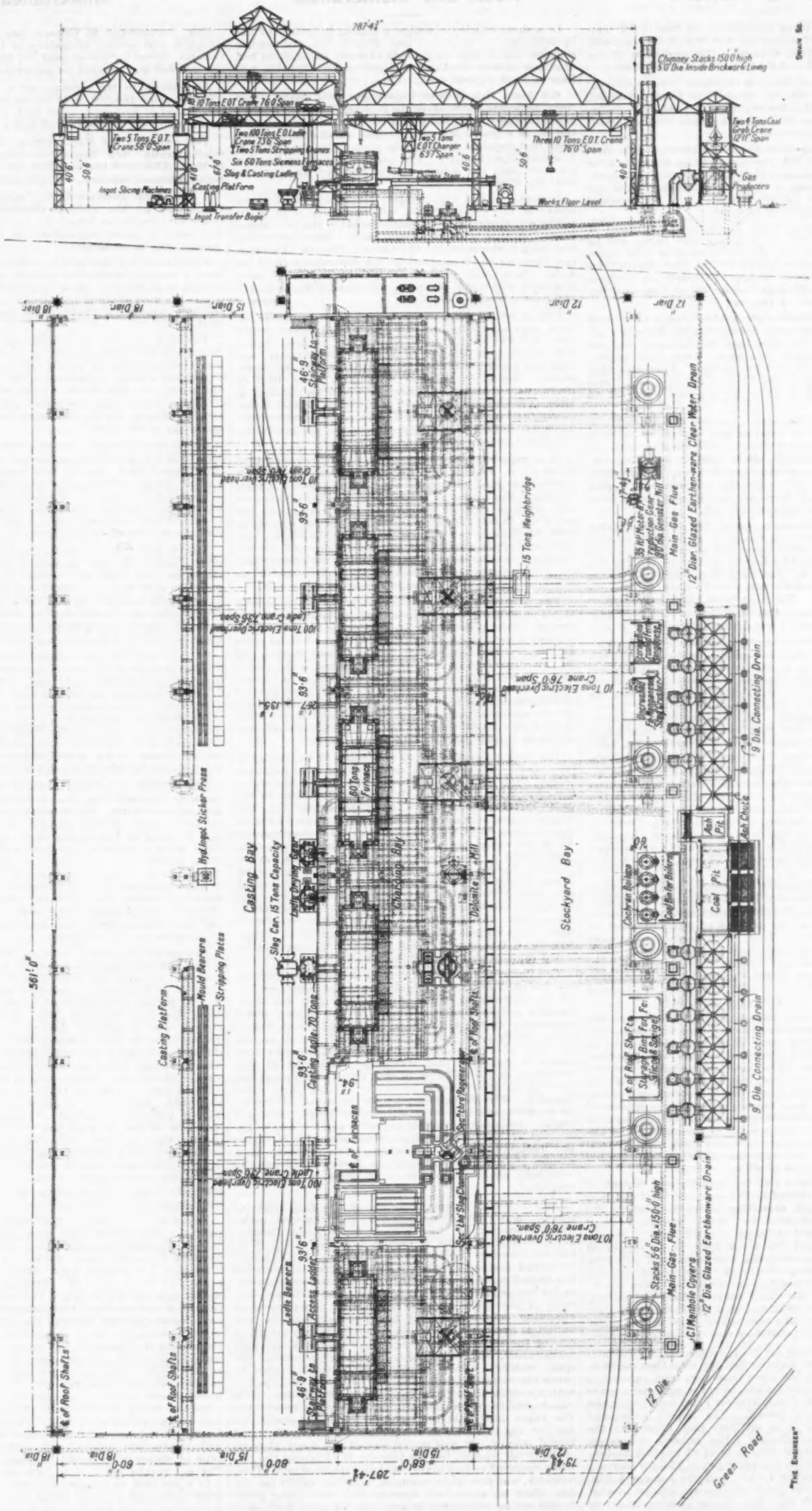
(For description see page 2)



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## PUBLISHER'S NOTICES.

*** *With this week's number are issued as Supplements One Two-page and One Four-page Plate illustrating the Penistone Works of Cammell Laird and Co., Limited. Every number as issued by the Publisher contains copies of these Supplements, and Subscribers are requested to notify the fact should they not receive them.*

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*By arrangement with Reuter's Engineering Service,* **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*


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## DEATH.

July 3rd, following an operation in a nursing home at Carlisle, Mr. ARTHUR WADHAM, founder and chief proprietor of the *Machinery Market.*

# THE ENGINEER.

*JULY* 6, 1923.

### Economic Railway Speeds.

WE have been taken to task by a correspondent for a leading article on "Railway Speeds" which appeared in our issue of June 8th. Our correspondent, Major Myers, has certainly read into our words far more than we had any intention of expressing. How he reached the conclusion that the line of argument we adopted would "amount to a declaration that for passenger transportation railways have reached the limit of utility," we are as little able to say as to understand his statement that our "present views, if applied to any of the older branches of engineering, would put an end to progress." Expressed as shortly as possible, the argument of our leader was first, that the travelling public was now so used to high speeds that it would not be in the slightest degree alarmed by any velocities the railway companies pleased to attain; but that we did not believe any great accelerations—which had been popularly discussed—were in contemplation; and that it was more important to run trains—which, as we showed, were increasing in weight—absolutely to the time-table than to save a few minutes in a run of several hours. We invite our correspondent to read the article and his comments upon it once more, and to admit that he cannot make them tally. To-day we take up the subject again on account of its inherent interest.

There is no manner of doubt that speeds far higher than those now commonly employed could be attained on British railways. We have splendid permanent ways, admirable signalling systems and steady rolling stock. Many years ago Mr. Rous-Marten defined the perfect locomotive as one that could haul a 150-ton train at an average speed of 60 miles per hour. The crack express trains of to-day are far heavier than Mr. Rous-Marten's ideal, weighing more nearly 300 than 150 tons, and although an average speed of 60 miles per hour has not yet been reached, it is almost within measurable distance. The weight of the trains that must now be hauled is the key to the whole problem, and it would be quite wrong to measure the advance in locomotive design by the speed, as Major Myers apparently invites us to do. What may be regarded as the economic speed of main line express trains has not materially altered for a great many years. It lies between 50 and 60 miles per hour. If the chief mechanical engineer turns out an engine which is capable of doing more, the traffic superintendent loads it up till he brings it back to that speed; if, on the other hand, he desires to haul heavier trains, he demands from the chief mechanical engineer locomotives powerful enough to give them speeds of the same order. "A mile-a-minute" may be regarded as a kind of vague standard which has controlled the development of railways in the past fifty years. Much higher speeds are run locally, but take it for all in all our railways are laid out for an average speed not exceeding 60 miles per hour, and to run much faster would involve an expenditure, in various directions, which we do not believe the railway companies will consider at the present time. Major Myers alludes to the fact that accelerated services attract passengers. We agree; and as long as the companies were in competition it was well worth their while to save a few minutes even on a long journey. But since grouping came in competition has gone out, and now that the companies cannot coax away each others passengers by offering them quicker services, we may rest assured that the best economic speed, whatever it may be, will be adopted, and that there will be no "stunting" for advertising purposes. To the enthusiastic engineer the locomotive may be the most important part of the train, but to the traffic manager the vehicles are, and frequently he looks upon the engine with scant respect. He knows full well that comfortable and quiet coaches, provided with all the amenities that the public now expects, are at least as attractive as very high speeds, and in order to satisfy his passenger he continually adds weights behind the tender, thus stultifying any efforts that the chief mechanical engineer may make to increase speeds, and giving him enough to occupy his thoughts in the production of an engine that will haul such long and very heavy trains punctually to the time-table.

The problem of railway speeds is, as we have suggested, purely an economical one. The conditions are very different from those which obtained in the early days of the railways, when the public grew really excited about velocities. The task the railway manager has to face nowadays is the carrying of the greatest number of people in the greatest comfort, and the speed he selects is that which will enable him to reach that object with the least expenditure. Hence, we must no longer measure the progress of locomotive engineering by the average velocities attained, but rather by the weight of train that can be hauled at what may be regarded as the standard express passenger-train speed. We hold that the locomotive designers are showing quite as much progress by producing engines which will draw trains of about 300 tons and even more, dead to time on a fast schedule, as they would do were they to turn out extra high-speed engines capable only of taking much lighter trains. Last week we visited all the London main-line termini and timed the arrival of principal expresses. With hardly an exception they came in either to time or before it. On Tuesday last, the Cornish Riviera express was composed of thirteen vehicles, weighing 445 tons dead. It was hauled by Dog-star and ran absolutely to time. The Bristol express, on the same day, with eight vehicles, weighed well over 257 tons, and, drawn by Knight Templar, it arrived at Bristol two minutes before time. We count these as great achievements, as great, certainly, as Rous-Marten's "150 tons at 60 miles per hour," and redounding at least as much to the credit of locomotive engineers as higher speeds with lesser loads would do. We cannot agree with Major Myers that limitations of speed "would put an end to progress" as long as it is brought about by the continual augmentation of the paying weight of the train, nor can we agree with him that limitation of speed indicates that "railways have reached the limit of their utility" as long as they are able to keep to the best railway schedules in the world with trains weighing between 300 and 400 tons.

### Specifications: Their Use and Abuse.

SPECIFICATIONS are, naturally enough, matters for constant consideration and discussion; being necessarily of the nature of compromises, there cannot fail to exist some degree of dissatisfaction with them, and in a well-drawn specification the best that can be said is that the discontent is fairly evenly divided between manufacturer and user. The viewpoint from which each regards the clauses of a specification is essentially different, and sometimes they even appear to be irreconcilably opposed. When this is the case, however, there must be something seriously wrong, since the end

to be served by any sound specification is in the main the accomplishment of a satisfactory transaction between manufacturer and purchaser. Unless both are reasonably satisfied, the end is far from being achieved. Viewed from this standpoint, we may consider some of the main grounds of complaint against specifications, complaints which, as a rule, are most loudly expressed by the manufacturer, although they find expression in a different and perhaps more serious way from the user.

Perhaps the commonest complaint is that the requirements of the specification are unduly severe, or that—being so severe—they should be interpreted with greater latitude by the inspector whose duty it is to enforce the various clauses. We do not wish to deny that there are cases in which specifications—even "Standard" specifications—have been drawn with undue severity. The manufacturer feels the onus of them and grumbles with a good deal of justification; but, on the other hand, the better makers know full well that it is bad policy to depress the standard demanded of their material. An easy specification makes manufacture easier and cheaper for a given firm, but so it does, as a rule, for trade rivals, with the result that competition will quickly reduce any financial advantage to be gained by cheaper production, and the only gainer will be in reality the purchaser, provided that the goods still meet his requirements. The skilful, well-equipped manufacturer therefore has more to lose than to gain by depressing a specification and thus opening the field to less favourably placed rivals. Further, the lowering of specification requirements often operates against the manufacturer to a most serious extent in quite another way—by spoiling the demand for the material. The engineer is bound to regard the specification figures as the best that he can really rely upon obtaining from the material, and if this "best" is unduly depressed his natural course of action is to turn to another material, perhaps of slightly higher cost and totally different manufacture, to replace what is no longer satisfactory for his purposes. Such cases are apt to arise particularly in non-ferrous alloys, where there is often keen competition between different types of material, or where a steel or steel alloy product may be preferred in such circumstances. We may take as an example an aluminium alloy which can be made to show a tensile strength of, say, 27 tons per square inch. Makers of this alloy, however, are afraid of occasional rejections and press for a specification figure of 23 tons per square inch, and the result is that a different alloy altogether is preferred, whereas with a more courageous specification limit the material in question might be widely used. Then again, as regards the interpretation of the various clauses of a specification, complaint is often made of too strict a degree of enforcement. Such a complaint is, in reality, a complaint against the undue severity of the tests imposed. If the terms of a specification are to have any really definite meaning there should be no complaint at full enforcement. The judgment of any individual inspector should not be allowed to be exercised as against the considered opinion of those who have drafted the specification, and that, in effect, is what "latitude" of interpretation really means. If the members of the drafting committee did not consider the simultaneous compliance with the whole specification essential, then it would be obviously necessary for them to omit any clause which they regarded as less essential or at least to make the passing of various tests alternative. The fact that this has not been done and that the full specification has been accepted by the manufacturer must logically imply that the tests specified, in their completeness, constitute a lower limit, and that to go below this is definitely to transgress the set limit. Even experimental errors in the tests are provided for by allowing repeat tests and, again, to go beyond them is to stultify the whole thing. If the tests are too severe, revision of the specification is the only proper course. The granting of latitude to inspectors is a step in a very dangerous direction, a direction which leads to a state of affairs not unknown in other countries where very stringent specifications have but a paper value and inspectors sometimes hold their posts only so long as they are adequately complacent.

The manufacturer, however, is not alone in the occasional abuse of specifications; engineers also sometimes make an unwise use of the data they contain. While it is perfectly true that the engineer cannot, for purposes of design, rely upon any figures for strength beyond those definitely specified, he is at times, we fear, too much inclined to look upon specifications as the only guide he has or needs to the properties of his material. In some cases this is fairly true; for instance, in rolled or drawn metal and similar completely homogeneous products. If the same plan were applied, for example, to castings serious results might follow. Whether the test piece required by the specification be "cast on" or a separate casting in sand or "chill," it is certain that the figure demanded of the test piece does not correspond to the actual strength of various parts of the casting itself; the latter may in some places be decidedly stronger, but in others will certainly be very considerably weaker than the test piece. There are probably other examples of the same kind. Here, as elsewhere, the engineer will, if he is a sound engineer, use his trained knowledge and judgment. If he does not, it is idle to blame either the specification or the manufacturer. At the hands of both user and manufacturer specifications require careful and intelligent handling; where this is done they become the medium for satisfactory mutual relations and there will be no "abuse" of the specification in either sense of the word.

## Literature.

*A Text-book of Ore Dressing.* By S. J. TRUSCOTT, A.R.S.M., M.I.M.M. Macmillan and Co., Limited. Price 40s. net.

EVERY natural phenomenon is pressed into the service of man, often, it has been observed, by methods of exquisite physical torture. Tubal Cain was the first metallurgist, if tradition is to be believed, and though probably he did not mine his ore, he selected and possibly dressed it, depending on weight and appearance, chipping out the good ore from the useless material or gangue. Miners and smelters of later date did not rely simply on the hammer, hand and eye. They crushed the ores and washed them, utilising small difference of specific gravity, and of the rate of fall of large and small particles of variable weight. Nowadays surface tension, ionisation, electric conductivity, and half-a-dozen other more abstruse physical properties are pressed into service to aid in the separation of valuable mineral from its gangue, and to part one mineral from another in order to facilitate metallurgical operations. The enormous development of oil or flotation processes during the last twenty years is the latest phase of mineral treatment, but it has not and will not oust the jig and the table. It has been the subject of innumerable papers and even of several text-books, but the existing treatises on ore dressing generally are so far out of date that they do not treat it adequately.

The author, professor of mining at the Royal School of Mines, has written this book primarily for his students, who are going through the course of mineral dressing at that school, but it will appeal to a far larger class of men who are interested in the treatment of ore—at stages intermediate between the mine and the laboratory. As the title indicates, the work is confined to the dressing of ores; the equally vast subject of the treatment of coal is not included, though the coal miner would be well advised to study the book for the sake of comparing the methods he adopts in breaking, sizing and washing coal. The mathematical, and more or less theoretical aspect, of investigating the descent of particles falling freely or under constraint in air and water, is touched upon but lightly, and generally the theoretical side of the subject is subordinated, as it properly should be, to the description of machines and the methods of using them. Even the old principle of ore dressing, as taught in the early youth of the reviewer, that equal sized particles could be separated by their weights, and that equally heavy particles by their size, is not insisted upon in so many words as the essential basis. Of course, it is still the foundation of ore dressing, but in practice the features of size and weight overlap to such an extent, that almost every machine and every process has to make a compromise between them. Besides, the modern worker has to consider surface tension and every other phenomenon he can urge to his service.

The book, in fifteen chapters, treats of washing and sorting; comminution; sizing in the laboratory and in practice by screens and by water; concentration by water; flotation process, machines, agents and theories; magnetic separation; electrostatic, pneumatic and centrifugal separators; heat treatment, such as roasting and calcining; sampling; and dressing systems and plants. Probably most readers will just turn to the two chapters on flotation processes, which occupy nearly one-fifth of the volume. In this section alone the author gives a history of the subject, which really first came into practical operation in the hands of Elmore, with the use of considerable amounts of oil. Now very small proportions are used, 1 per cent. or under in most cases; but the action of the oil is supplemented by vigorous agitation, so that the selected mineral is carried up in a froth of air, oil and water, while the gangue particles are wetted, air bubbles do not adhere to them, and accordingly they sink in the water. The theory of the process, in so far as the relation of the mineral, oil, air and water are concerned, is still in dispute, but the author seems to rely mainly on surface tension rather than on chemically electrolytic explanations. At present the arguments on the theoretical side are nearly as discursive and confused as were those on the legal side in the American courts, where claim was made for the exclusive use of limited percentages of oil. An enormous amount of work has been done in investigation, and vast quantities of ores are now treated by these processes. The work done is ably summarised by the author, who gives a clear and succinct account of the machinery, the various oily and other reagents used, and the methods of dealing with the froth. Complex ores, containing lead, zinc, copper and the precious metals are now amenable to treatment, and Professor Truscott shows how the process is applicable, not only for separating mineral from gangue, but also to part mineral from mineral, such as galena from blende.

Since the days of his predecessor, Warington Smyth, at the Royal School of Mines, ore dressing has seen many changes besides the introduction of the flotation processes. Apart from that, however, it would be difficult to select anything that is really not a development of previous types of plant and processes. Mechanical thickeners for slimes and pulps may perhaps be regarded as something new, while ball and tube mills were scarcely used. On the other hand, all the modern forms of riffled shaking tables, vanners, jigs and so forth, are very great improvements on the machines of forty years ago. The history of the older forms and the introduction of new devices is not included in the author's scheme of treatment—it would make the book too unwieldy. He takes two or three forms of typical machines in each class as subjects for good sectional or perspective illustrations, and does not waste time in describing the details. These are left for the student to read in the picture, but he does give plenty of information about the practical working of the class of machine, and briefly indicates the out-turn for the power and water used. Numerous examples of flow sheets are scattered throughout the book, so that the intelligent student ought to be able to gather some idea of what any ore should require in the way of plant and power, apart from the feeding and conveying arrangements, which are not included in the author's treatment of the subject.

Within the limits he has imposed upon himself, we think that the author has treated his subject clearly and satisfactorily. He has missed but little of recent developments in ore dressing, and he has incidentally thrown out many suggestions as to lines of future progress with complex ores and rarer minerals. Curiously enough on one of the commoner ores he is incorrect in his statements on page 3 that iron ore of 50 per cent. is as low as generally can be smelted, seeing that blast-furnace burdens of Oxford and Northampton ores often carry as little as 33 per cent. of iron or even less. Possibly, however, 50 is a misprint for 30, but this is a small error in relation to the magnitude of the work, and it is hard to find others of importance.

For the student especially, and for anyone interested in the subject, Professor Truscott's book must be regarded as a good preliminary treatise and as an introduction to the older and the more specialised volumes. It omits little of the elements, treated in a reasonably advanced fashion, and the author promises a similar work on coal, to be produced, we hope, in the near future. He has, at least, made a very good endeavour to satisfy a reader who, like buyers of ore, "sometimes consider that a ton should be as near a ton and a-half as can be managed."

## Obituary.

### JAMES GOLBY BARFORD.

WE regret to have to announce the death, on the 29th ult., of James Golby Barford, chairman of Barford and Perkins, Limited, of Peterborough.

Mr. Barford, who was in his sixty-second year, was the son of the late Mr. William Barford, one of the founders of the firm. He was educated at a private school and at Christ College, Finchley, subsequently spending a year in Austria before serving his apprenticeship with E. R. and F. Turner, Limited, engineers, of Ipswich.

Since his election in 1905 he was, up to his death, on the Council of the Smithfield Club, as was his father before him for many years. He was a prominent life member of the Royal Agricultural Society of England, and was on the Councils of the Peterborough Foxhound Show and the Peterborough Agricultural Society. When Barford and Perkins, Limited, combined their interests with those of the Agricultural and General Engineers, Limited, he was elected to the Board of the latter company. During the war he was actively connected with the Red Cross, being assistant county director of the Soke of Peterborough Division of the Northamptonshire Red Cross Committee. He was also chairman of the special committee which was set up to run the auxiliary military hospital at the Bishop of Peterborough's Palace.

# The Royal Show at Newcastle.

No. II.*

THE Royal Agricultural Society has been fortunate this year in the choice of its show ground, which is situated on the town moor at Newcastle-upon-Tyne. The site chosen is larger than usual, being about 140 acres. It is within a few minutes' ride by tramcar from the centre of the city. Beyond the awards of the Society's silver medals for new implements for agricultural or estate purposes, there are no competitions for awards this year, and there are fewer novel appliances than usual. For the silver medals there are about fifty competitors, including those showing incubators, pumps, threshing machines, electric light plants, potato diggers, steam tractors, manure distributors, milking machines, seed drills, &c. To some of these we shall refer in detail in due course. The most noteworthy feature of the implement section is the number of appliances for use in connection with roadmaking. In this connection the number of engineering firms that are now devoting their energies to the building of road rollers is remarkable. On the other hand, there is a decrease in the number of agricultural tractors shown, and we looked in vain for some of the very high-speed petrol-electric lighting sets which formed such a pronounced feature of recent shows.

To make hay without the aid of the sun is a problem that many farmers are having to face in the present sunless summer. In some parts of these islands, unfortunately, this is a common experience. At the Royal Show Mr. R. Borlase Matthews, M.I.E.E., has an exhibit which he claims will enable farmers to be quite independent of the sun's rays for drying their hay crops. Briefly, Mr. Borlase Matthews' method consists in making a stack in such a manner as to allow air to be forced through it from below by means of a fan to blow off the moisture on the surface of the grass stalks. After the blowing operation has been in operation for a few hours the fan is shut off, and in the meantime bacteriological and chemical actions have begun to take place, which generate heat in the stack and "cure" the contents. The first portion of the stack to become heated is at the bottom, and the desired heat requires about twenty-four hours to generate. Air is then blown into the stack again to drive off further moisture, and the stack is allowed to stand again, when a further layer of the grass becomes heated, and so on until the whole stack has been subjected to the repeated treatments. The inventor of the process claims that hay made in this manner is generally of better quality than that made in the ordinary way, and, in spite of the extra weight of the green grass to be carted, the cost of making hay in this manner will compare very favourably with the older method, owing to the saving of labour in connection with turning and raking, neither of which operations is necessary. In the experimental stack which Mr. Borlase Matthews is showing the air is blown by means of a fan which is driven by an electric motor deriving current from the generator of a petrol-electric omnibus chassis. This invention is entered for the Society's silver medals. Other interesting exhibits on Mr. Matthews' stand are an electrically operated threshing machine, which is placed on the petrol-electric chassis, from which it derives its current. This arrangement is claimed to be much more quickly handled and manœuvred alongside the stack than an ordinary threshing machine, while by dismounting the thresher the motor vehicle can be made available for farm purposes. For farms on which a supply of electricity is available a portable electric motor of 5 horse-power, made by the Swedish General Electric Company, is shown. This handy arrangement is fitted with a speed reduction, so that machinery can be driven off the motor pulley direct or at a reduced speed off a countershaft. Mr. Matthews is an ardent advocate of electricity for all kinds of purposes on the farm, from incubators and wireless telephony to ploughing. In this connection he is perhaps ahead of the times.

A new implement for tilling the land by rotary tines is shown on the stand of Simar Rototillers, Compton-street, Goswell-road, London. This machine is an improvement on one that we referred to last year, and is the outcome of three years' experience under working conditions. The engine is of the two-stroke single-cylinder type, with a cylinder capacity of 850 c.cm. and a brake horse-power varying from 7 at 800 revolutions to 10 at 1600 revolutions. The lubrication of the engine is effected by mixing oil with petrol. The big ends are mounted on double-roll roller bearings, and the crank shaft on substantial ball bearings. An automatic oil injector is provided to facilitate starting. For stationary work of a light nature, a pulley is fitted on the front of the engine. The standard width of the tiller has been increased to 36in., but this width is reducible to either 30in. or 24in. The steering is so arranged that the machine can be driven from any one of a large number of positions. The details of construction of this new machine are clearly shown in Fig. 7, while Fig. 8 represents a general view. From the engine, power is transmitted by means of a clutch of the conical variety and a splined shaft to a steel worm and phosphor bronze wheel, thence by hardened nickel steel gear enclosed and running in oil. Two speeds of progression are provided by means of a lever, as in motor car practice. The top speed corresponds to a travelling speed of 1½ miles per hour, and the bottom speed to ¾ miles per hour when the engine is making 1400 revolutions per minute. The rotary tiller is driven by a bevel pinion and crown wheel enclosed in an extension of the gear-box, which forms part of the body. The tiller normally runs at 100 revolutions per minute. The crown wheel is mounted on the centre of a tiller axle, which is parallel to the driving wheels, but the drive of the former is independent, being connected to or disconnected from the main shaft by means of a splined coupling. This arrangement permits of examination of the tiller, and allows the machine to go about from place to place under its own power, without the tiller being in motion. On the tiller axle are mounted two sleeves one on either side of the crown wheel casing, each of which carries ten coil springs of special shape. On the extremities of these springs are fitted semi-circular hooks of hardened and tempered steel, which are the actual working tools. This arrangement provides an elastic medium, which allows the hooks to give way in any direction when meeting stones, roots or other obstacles. It will be seen that the tiller is covered by a hood, which prevents stone or soil from being thrown out. The depth of tillage is variable from 1in. to 10in., and is regulated at will by a shoe situated under the tiller gear-box. The driving wheels are of pressed steel with angle iron treads 18in. diameter mounted on conical hubs. The external wheel track is 24in. The total length of the machine from the starting handle to the extremity of the guiding arm handles is 7ft. 6in., and the greatest height 37in., the weight being 6½ cwt. It is claimed that the machine can till upwards of 2 acres per day of ten hours, according to the depth and nature of the ground.

Although much progress has undoubtedly been made in the design and efficiency of threshing machines since their introduction in the middle of the last century, the general principles underlying their operation remain substantially unchanged, and there has been no reduction in the amount of hand labour required. In operating an ordinary threshing machine to the best advantage, it is customary to have two men at least on the stack from which the unthreshed sheaves are taken, a man to receive the sheaves on the thresher and cut the bands, and another man to open out the sheaves and feed them on to the threshing drum. In order to save some of this labour, William Foster and Co., Limited, have designed an appliance which should command the attention of farmers. It is called a "stack feeder," but this title is somewhat misleading, as the apparatus is intended to supply the threshing machine with material from an adjacent stack. With this new invention labour is dispensed with on the thresher, and only one man is required on the stack to feed the sheaves into the apparatus. It consists primarily of a conveyor, driven from some convenient shaft on the threshing machine and running in a trough—see Fig. 9. The belt carries transverse teeth spaced at suitable distances apart to transport the sheaves endwise towards the thresher. The feeder trough carries rotating disc knives which cut the straw bands, while close behind is a combing cylinder, also fitted with transverse teeth at regular intervals on its circumference, which acts on the sheaves by rapidly combing away the top layers of straw. This is brought about by reason of the combing cylinder running much faster than the conveyor belt. The top straws of the sheaf which are being combed by the cylinder

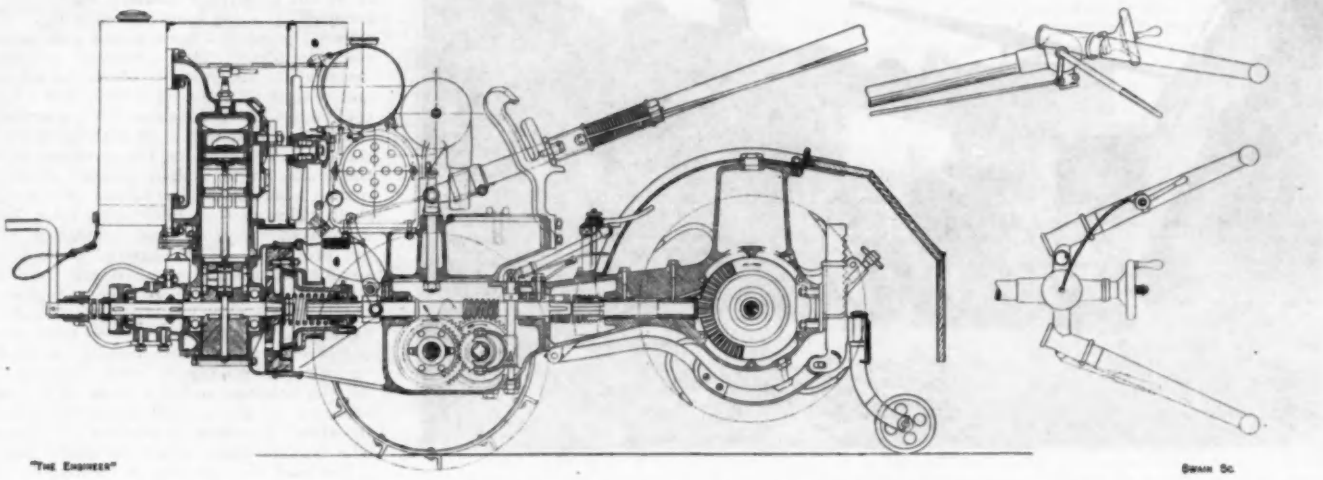



FIG. 7—SELF-PROPELLING ROTARY-TINE TILLING MACHINE—SIMAR ROTOTILLERS

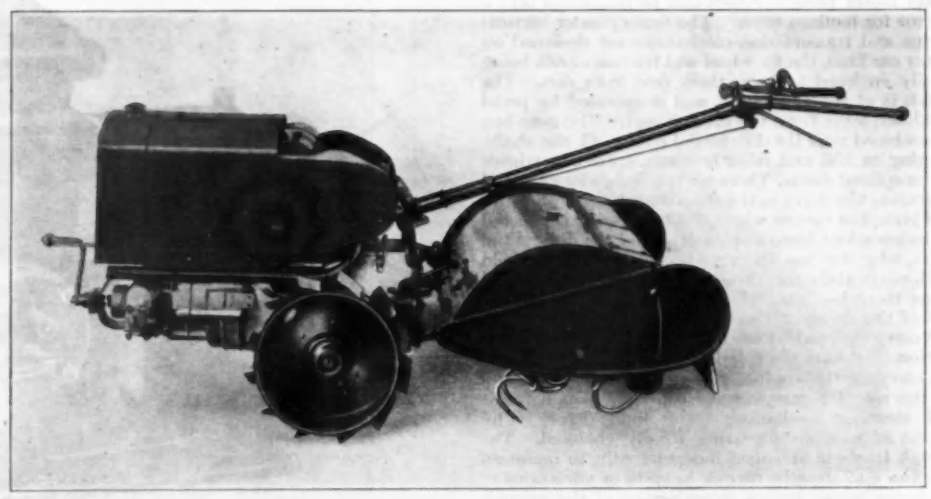


FIG. 8—ROTARY-TINE TILLING MACHINE—SIMAR ROTOTILLERS

* No. I. appeared June 29th.

move approximately at the speed of that cylinder, while the lower straws move at the slower speed of the belt. The centre portion of the sheaf is gradually elongated forward by reason of the intermingling and entrainment of the straws, the result being that the sheaf is projected in a continuous stream into the thresher drum. There is an adjustable governing device which can be set to allow the maximum size of sheaf to pass and no more. Thus, if a sheaf of

FIG. 9—FOSTER'S STACK FEEDER

abnormal size be thrown into the trough, the only result is a temporary slowing of the feed web until the extra bulk has been reduced by the combing cylinder. The stack feeder is counterbalanced by means of a beam, and the elevator or trough gradually falls as the size of the stack diminishes. The apparatus is provided with means for slewing to enable it to work equally well on either side of the thresher, and the conveyor belt is arranged to run at such a speed as to take from twenty-five to thirty sheaves of ordinary binder-tied crop per minute. When a stack is finished, the feeding apparatus can be packed up on top of the thresher, on which it occupies a comparatively small space vertically. Its total weight is about 6 cwt., and the power required to operate it about 3 horse-power.

On the stand of John Fowler and Co. (Leeds), Limited, is shown for the first time a 30 brake horse-power motor plough, which can be converted into a tractor for haulage work. The four-cylinder vertical engine and transmission mechanism are designed on motor car lines, the fly-wheel and friction clutch being totally enclosed to keep them free from dirt. The clutch is of the plate type, and is operated by pedal and hand lever from the driving seat. The gear-box is combined with the differential casing, all the shafts running on ball and roller bearings. The gear wheels are on splined shafts. There are two speeds forward and a reverse; the drive to the cross shaft being by a worm and phosphor bronze wheel. The steering is effected by independent brakes on each side of the differential shaft, whereby one driving-wheel is retarded or held stationary while the drive through the other wheel turns the other road wheel rapidly or slowly at the will of the driver. The frame sides are of cast iron and carry the road wheels and lifting screws. Channel section steel bars are fitted on the front of the frame for carrying the engine, gear-box and radiator, and on the rear for carrying the controls, plough frame and steering mechanism. The final drive is by means of cast steel gearing totally enclosed. The plough frame is arranged independently to maintain an even and straight furrow in spite of variations of the main frame due to irregularities of the ground. For conversion to a tractor a bracket is fitted on the plough frame into which the castor wheel and spindle can be fitted after removal of the plough bodies. This shortens the wheel base, and in this position the rear wheel is controlled by the hand wheel for steering purposes. At the same time, by removing a catch, this wheel can be left free to swivel so that sharp turns can still be negotiated by the independent brakes referred to above. Messrs. Fowler also show one of their well-known steam cable plough engines, a 70 horse-power motor cable ploughing engine, with four-cylinder motor and Ackermann type steering gear and a combined road rolling, tar-spraying, grouting, and gritting machine. The 70 horse-power cable ploughing motor has four cylinders and is fitted with a governor and separate throttle controlled from the footplate. Lubrication is by forced and gravity feeds, and a safety cut-out is fitted, so that when the oil in the crank case gets too low the engine is automatically stopped, and cannot be started again until the lubricating oil is brought up to the working level. The bottom of the gear-box is strengthened to carry the horizontal winding drum and coiling gear. Three ploughing speeds and three road speeds, both forward and reverse, are provided. The starting is accomplished by a single-cylinder air-cooled engine, connected to a shaft which carries friction discs; these discs are brought into contact with the fly-wheel of the main engine by means of the starting pedal. The drive is transmitted to the hind axle by bevel and spur gearing. The differential can be locked from the footplate. The main frame is of tubular formation, with side plates and channel bars supporting the engine and radiator. The tubular frame casing carries the friction clutch, change speed gear-box and winding gears; the high-speed gears are enclosed and run in oil. The carburetter is suitable for either petrol or benzol, and special vaporisers can be fitted for either paraffin or alcohol.

The National Gas Engine Company, Limited, of Ashton-under-Lyne, is exhibiting one of its four-cylinder vertical gas engines, capable of developing 180 brake horse-power as a constant working load. It is direct-coupled to an E.C.C. electrical generator. This engine operates on the four-stroke cycle. The reciprocating parts are totally enclosed, and the lubrication is effected by means of a pump supplying oil under pressure through the crank shaft to all bearings. It is claimed that, owing to its excellent turning effort and to the good governing obtainable, engines of this type are suitable for driving both alternating and direct-current generators. The engine is intended for operation on all kinds of gases, such as town, producer, blast-furnace, or coke oven gas. Engines of this type are manufactured with two, three, four and six cylinders, developing, respectively, 90, 135, 180 and 270 brake horse-power. In conjunction with the above engine, there is on view a suction gas plant designed for gasifying anthracite or coke. This plant, which is of the conical grate type, is capable of supplying gas for an engine of 95 to 110 brake horse-power. Another exhibit is a small 2-kilowatt compact lighting set, consisting of a standard engine and chain-driven dynamo, which has just been placed upon the market. The set is supplied with a totally enclosed silent inverted-tooth chain running on machine-cut chain wheels. It is intended for operation on town gas, petrol, alcohol, or paraffin. The bed is made in such a way that any well-known make of electrical generator can be fitted, provided the speed of the generator is within prescribed limits. These sets are manufactured up to 5½ kilowatts capacity. There is also shown a portable 5 horse-power gas engine and charcoal gas plant. This combined set was originally designed for countries in which the price of paraffin and refined oil are prohibitive, and where the user could make his own charcoal. The gas plant generator is simply a cast iron shell without brick lining. All the steam required for the generator is raised from the grate, so that there are no complicated pipes in the system. The scrubber is a small cast iron shell which can be filled with coke, broken brick, &c. Water cooling and circulating arrangements are provided. With charcoal there is generally a small amount of tar produced, and the engine is fitted with a small tar-catcher. The engine is of standard design. A 5 to 6 horse-power vertical engine, also exhibited, is arranged to run on town or suction gas, petrol or paraffin. It is specially intended for driving agricultural machinery and domestic appliances. All the bearings and the whole of the moving parts are easy of access, and when fitted with a heavy fly-wheel the engine is suitable for dynamo driving. The makers claim that it is easily started up, has a low fuel consumption, is thoroughly reliable, and is in every way an ideal prime mover for agricultural work or country house lighting.

The exhibits of Clayton and Shuttleworth, Limited, of Lincoln, comprise one of their latest 7 horse-power general purposes traction engines, fitted with single cylinder, winding drum, water-lifter and Pickering type governor. A compound steam motor tractor has a boiler of the "Belpaire" type designed for 200 lb. working pressure. The engine is fitted with two travelling speeds and will, it is said, easily haul 7 to 8 tons in a trailer wagon. It is mounted on springs at the front and rear. The travelling wheels are fitted with rubber tires, so as to make the tractor

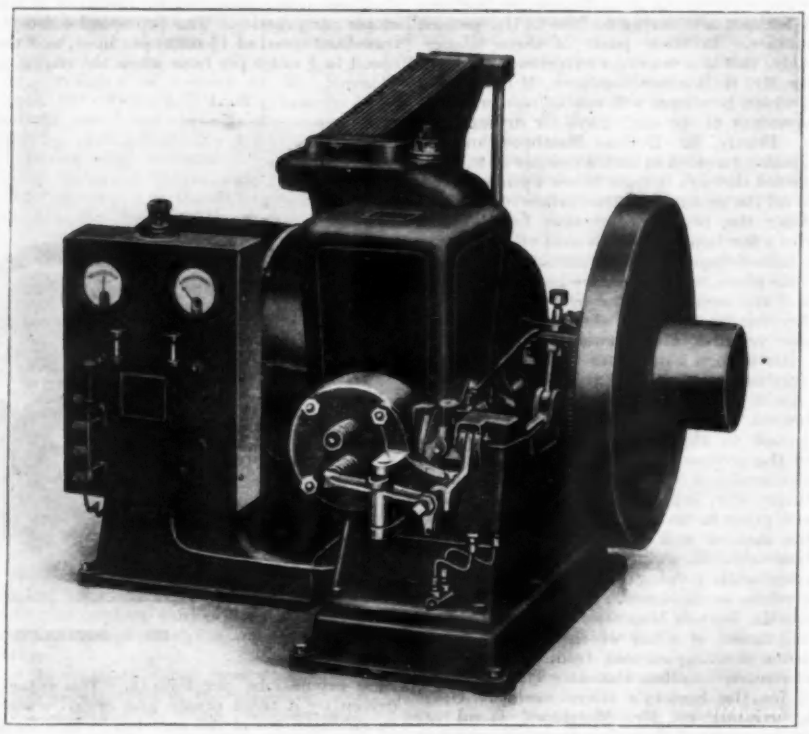


FIG. 10—1200-WATT COMBINED LIGHTING AND POWER SET—WORTHINGTON-SIMPSON

speedy and easy running. The firm's exhibits of crude oil engines comprise three sizes, viz., 35, 20 and 10 brake horse-power. These engines are of the valveless type and are stated to run on practically any oil obtainable. They are fitted with the firm's patented detachable cover, which allows easy access to the crank shaft and connecting-rod bearings. It is pointed out that owing to a differential governor being fitted, the engine is capable of working on loads from full to light without water injection, and also without having to be fitted with a light running device. This firm is also represented by

one of its latest type 54in. large size thrashing machines. The principal spindles are fitted with "Skefko" ball bearings to reduce the power required to drive, and a specially designed web feeder, which dispenses with the services of one man, is fitted. A light type tractor thrasher shown is 54in. wide, and is fitted with 20in. drum with eight beaters, self-oiling bearings, and similarly constructed on their standard lines. This machine is most suitable for the farmer who possesses a ploughing tractor and wishes to do his own thrashing. Another special exhibit is a smaller size thrasher, 3ft. wide, which was designed with a view to meeting the requirements of the Scottish crofters and others who require a machine which will suit their requirements at a low price.

Crossley Brothers, Limited, Openshaw, have a representative selection of oil and gas engines of moderate sizes, all of which are shown in motion. There is also a Crossley open-hearth suction plant using anthracite as fuel. In addition to supplying a 37 horse-power engine, this plant is capable of generating gas for industrial heating purposes. It is provided with a heating attachment, including a purifier in addition to the usual cleaning scrubbers for the purpose of removing all traces of sulphur and other finer impurities from the gas. The heating gas is drawn through the purifier by a belt-driven "Docking" compressor, and is delivered at a slight pressure into a service main, so as to ensure that the heating gas used will give maximum working temperatures, efficient combustion and high economy. The method of working is demonstrated in practice by heating up a small furnace suitable for small forgings. The Crossley small oil and petrol engines are well known to our readers. They are of the horizontal type, and especially suitable for farm use. They are built both portable and stationary—hopper-cooled or tank cooled. The engines have moderate working speeds to keep down wear and tear and are of robust construction throughout. Their design is on simple lines to ensure reliability and economy in both fuel and lubricating oil.

In addition to a full range of oil engines, milking plants, cream separators and pumping machinery, Worthington-Simpson, Limited, Kingsway, London, W.C. 2, show a 1200-watt slow-speed direct-connected power and lighting set—illustrated in Fig. 10. This is a very compact little plant of substantial design. The engine is of the hopper cooled type, with a radiator in a nearly horizontal position, and sufficiently inclined to drain all the water of condensation back into the hopper, while vapour rising from the hopper is quickly condensed owing to the current of air which passes through the radiator. The engine and generator are mounted on a cast iron bed-plate that extends under each. The fly-wheel on the right-hand side of the engine has been filled in with sheet metal to give it the appearance of a disc wheel. The magneto has been eliminated, and the engine equipped with a jump-spark plug, taking current direct from a battery. When it is desired to use the engine for power purposes, independently of the generator or battery, the rheostat is turned back to cut down the voltage, and the switch is opened to prevent any current going to the battery. The entire power of the engine is then available for driving machinery direct. This plant is shown in operation furnishing light to the company's offices on the show ground.

The exhibits of Robey and Co., Limited, of Lincoln, include a tandem steam road roller with rapid reverse gear. This machine is made in sizes varying from 5 tons to 8 tons, and its adaptability and simplicity render it specially suitable for all modern forms of road construction, such as tar-macadam, asphalt and bituminous carpeting, and for all gravel and metal roads. One of the outstanding advantages claimed for the "Robey" tandem roller is its instantaneous reverse which, in conjunction with the chain drive, is said to obviate any tendency of the roller to leave waves in the road surface when reversing, a perfectly level and smooth surface being obtained without any ridging.

The Robey six-wheel steam wagon shown has already been dealt with in THE ENGINEER. This wagon was designed to meet the insistent demand for a steam vehicle capable of carrying heavier loads than hitherto possible over long distances at a high speed, and to take the place of a 5-ton steam wagon hauling a trailer, for which the maximum speed legally permissible is only 5 miles per hour. The "Robey" six-wheeler, on the other hand, has itself a load capacity of 10 tons, and is permitted by law to travel at 12 miles per hour, thus performing the work of an ordinary wagon and trailer at nearly 2½ times the speed permitted to this latter arrangement. Further, it is stated that it will do this work at less than one half the expense in fuel of any petrol combination. Another exhibit is a portable engine of the enclosed type. This engine has been designed for working under conditions in which the air is heavily laden with dust. All the working parts are totally enclosed, and the efficiency of the engine is increased by mounting the crank shaft in ball bearings. The crank case forms an oil well, in which the connecting-rod runs, thus providing an efficient means of splash lubrication to all working parts.

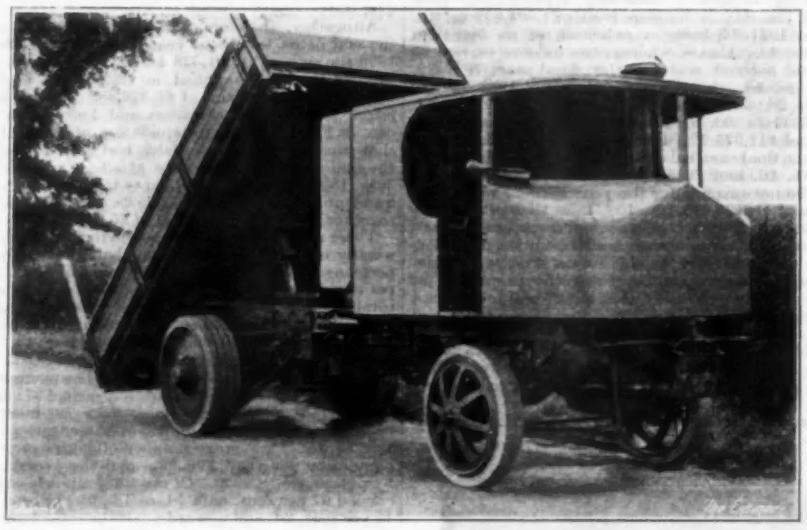


FIG. 11—THREE-WAY TIPPING SUPER-SENTINEL STEAM WAGON

The tractor type roller shown by this firm is readily adaptable for use either as a roller or tractor as desired. The parts required are few in number, and consist of a pair of hind wheels and a forecarriage complete with front wheels. The process of conversion necessitates no heavy lifting tackle. The advantages of this arrangement are obvious, as at a comparatively small enhanced initial expense a double purpose engine is secured, which can be used for road rolling, hauling, thrashing, ploughing, sawing, or driving any other machinery by belt. Two single-cylinder crude oil engines, one of 15 and the other of 30 brake horse-power, the latter driving a vertical two-stage air compressor by belt, and a 15 brake horse-power single-cylinder marine type crude oil engine, with reverse gear, are also shown.

The new Super-Sentinel steam wagon, of which three types are exhibited by the Sentinel Wagon Works (1920), Limited, Shrewsbury, is a greatly improved machine. The chief alterations as compared with earlier wagons, is in connection with the engine and boiler, both of which have already been described in THE ENGINEER. It may be said here, however, that the newly designed engine has the differential gear included in the crank shaft in an ingenious manner, which enables the gearing to operate under the best possible conditions, as regards lubrication and freedom from dirt, in conjunction with a stationary back axle. The steam valves are operated by two cam shafts situated in the crank case, where they are effectively lubricated and give improved steam distribution with higher economy. The valves are placed at the front end of the cylinders, where they are accessible for regrinding, and double glands are provided for the piston-rod to prevent leakage of steam into the crank case. The principal improvement in the steam boiler is the method of constructing the inner shell. This now has a series of oblique "landings" pressed in it which allow the tubes to be arranged with a much larger slope and tangentially to the stoking hole. This arrangement gives a more active circulation of the water and prevents accumulation of ashes and dust on the outside of the tubes. Boilers are designed for a pressure of 230 lb. per square inch. One of the machines—shown in Figs. 11 and 12—has a three-way tipping body, which is operated in an ingenious manner by hydraulic ram without the use of a pump. To obviate this the necessary pressure under the ram is produced by means of a steam injector, a use for this instrument which we believe to be entirely new. The hydraulic cylinder is arranged vertically between the chassis frames and centrally under the wagon platform, which can be hinged in three directions, viz., at the end or on the two sides. Another type of machine shown by the same firm is a six-wheeler—an illustration of which is shown in Fig. 13. This machine has been designed in order to take advantage of recent legislation, which permits a six-wheeled vehicle, subject to certain conditions, to haul a 10-ton load at a speed of 12 miles per hour instead of 5 miles per hour, as in the case of a separate trailer. The hind portion of the wagon is pivoted to the tractor portion and has a deep light steel underframe. It gives a very large platform area up to 24ft. long by 7ft. wide with a low loading height. The chief features of the trailer are its all-steel construction, fewness of parts, large bearing surfaces, flexibility of springing and powerful brakes. Provision is made for flexibility of movement at a junction of the trailer to the tractor. The tractor is built to burn coal, coke, oil, or charcoal or wood. On good level roads it will pull 20 tons to 30 tons, and

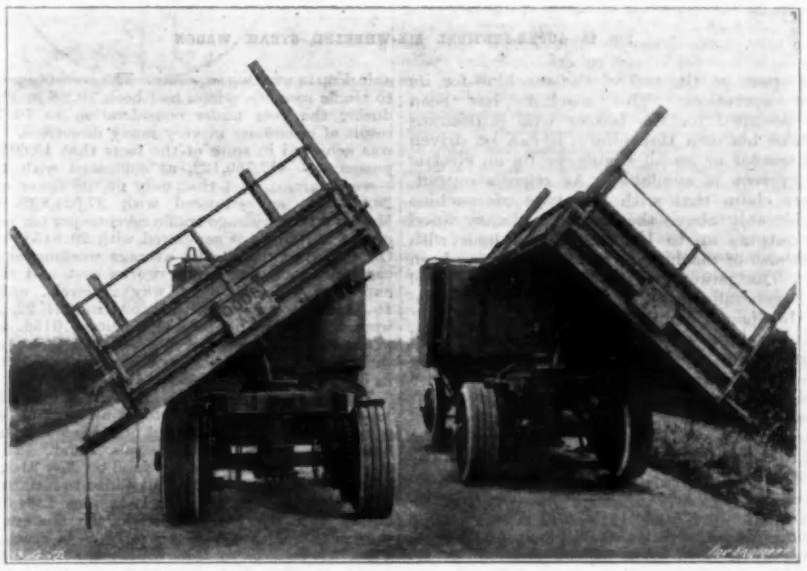


FIG. 12—THE SUPER-SENTINEL WAGON TIPPED TO LEFT AND RIGHT

the makers claim that it will haul 10 tons up a gradient of 1 in 6. The motive mechanism is the same as that of the wagon made by the same firm.

Another notable exhibit in the steam wagon section is that of Fodens, Limited, Sandbach. The new 6-ton wagon made by this firm has a boiler with 90 square feet of heating surface, and is designed for a pressure of 220 lb. per square inch. The cylinder diameters are 4½in. by 7in. and the stroke 7in. Three gear ratios are provided, and the Ackerman system of steering has been adopted to enable a better control to be maintained when running at the high speeds which are permitted with the use of rubber tires. The same firm exhibits a 4–5 ton trailer, suitable for use with the above wagon. The frame of this trailer is built of steel channels welded to-

gether, and the same remark applies to the fore-carriage. Platform area is 78 square feet; the wheel base, 7ft. 3in., and the track, 5ft. 6in. The road wheels, which are 771 mm. in diameter, are of cast steel, and powerful band brakes operate on steel drums on both rear wheels.

The exhibits of Marshall, Sons and Co., Limited, Gainsborough, include steam rollers, steam tractors, portable steam engines and oil engines, both horizontal and vertical, on the two-stroke principle. The most novel exhibit, however, is an all-steel thrashing machine. This machine is of the "finishing" type, 4ft. 6in. wide, with large capacity thrashing drum fitted with eight beaters. The frame is built up of steel sections designed to withstand strains of working and travelling, and the sides and ends are neatly finished with steel sheets. The machine has a straw rack, shoe containing a caving riddle of special design, and bottom hopper with special riddles for first dressing. The internal grain elevator has steel cups, and is arranged for delivering the grain at the back end of the machine, direct into sacks, if required, through the smutter and back-end dressing apparatus, or direct to the back-end dressing apparatus without passing through the smutter. The smutter is of the usual English type, and a back-end blower with back-end dressing apparatus, fourth blast, rotary corn screen for grading the grain into three different qualities, are included in the equipment. The bearings of the drum shaft, smutter shaft, main blower shaft, back-end blower shaft and the outside bearings of the shoe crank, are all of the ball-race type, self-aligning. The machine is mounted on four light wrought iron travelling wheels, and the usual draught attachments are provided. Its feeding arrangements are identical with those of the standard English wood machine, and there

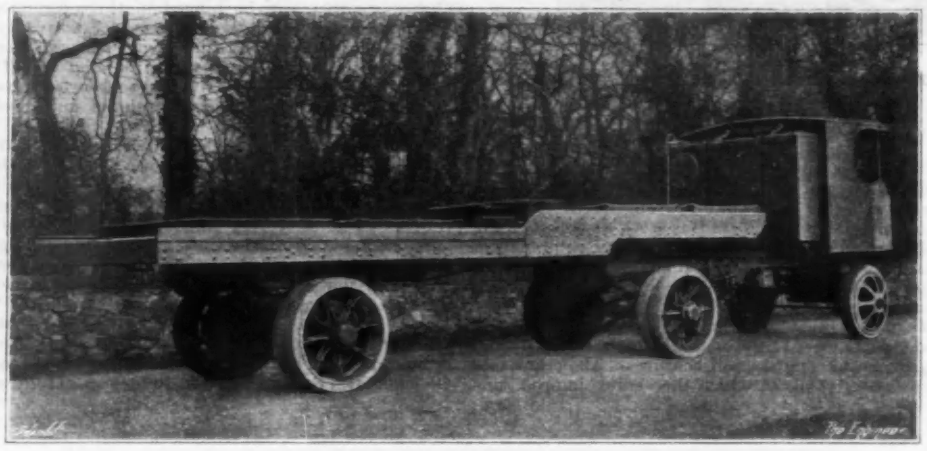


FIG. 13—SUPER-SENTINEL SIX-WHEELED STEAM WAGON

is a large space at the top of the machine for its convenient operation. This machine has been primarily designed for the farmer who is desirous to undertake his own thrashing; it can be driven by an oil tractor or an oil engine, or by an electric motor if current is available. As regards output, the makers claim that with this type of machine it is considerably above that of the ordinary wood thrasher, outputs up to 150 bushels per hour with the largest size of machine of the series having been obtained. The power required to drive the steel machine is generally less than that required for the ordinary thrasher of similar size.

The chief exhibit of Armstrong, Whitworth and Co., Limited, is a compound steam roller. This is a similar machine to that illustrated and described in THE ENGINEER for March 30th last. It is built in three weights, namely, 8, 10 and 12 tons respectively, and the boiler is designed for a working pressure of 180 lb. The engine has piston valves of the internal admission type. Both cylinders and steam chests are fitted with renewable liners. The cylinder casting is of the monobloc type, and is so designed that in combination with the steel plate saddle seating on the boiler it forms a capacious steam reservoir. By this arrangement a large area of the cylinder walls, and also those of the steam passages between the high and low-pressure cylinders, are in direct contact with the live steam in the boiler, which prevents any great drop in temperature of the steam in the cylinders. The roller wheels are built up of two solid dished steel plates forming the centre, which are bolted to a heavy cast iron hub and rim by turned bolts and nuts and fitted with lock washers. The edges of the dished steel plates are machined, and fit accurately on the hub and rim, which are respectively turned and bored to receive them. The load is thus transmitted from the hub to the rim directly through the plates and independently of the bolt fixing. The fork carrying the front pair of roller wheels, usually made in cast iron, is, in the case of this machine, made of cast steel.

## Glasgow Tramways.

THE annual reports on the working of the Glasgow tramways always provide interesting reading, and the report dealing with the year from June 1st, 1922, to May 31st, 1923, which has recently reached us, is in this respect in no way behind those which have gone before it. A brief reference to the report was made in our issue of June 22nd, and we propose in what follows to refer in more detail to it. It appears that during the period under consideration, the traffic receipts amounted to £2,252,204 12s. 6d., which with "other receipts" amounting to £4272 14s. 4d., brought the total income up to £2,256,477 6s. 10d., as compared with £2,350,752 12s. 9d. for the preceding year, a reduction of £94,275 5s. 11d. The working expenses, excluding depreciation, were £1,592,684 19s. 8d., as compared with £1,804,652 0s. 4d. in the year 1921–22, being a reduction of no less than £211,967 0s. 8d. Hence, whereas the balance carried to net revenue account was for the fiscal year 1921–22, £546,100 12s. 5d., the figure for the year 1922–23 was £663,792 7s. 2d., an increase of no less than £117,691 14s. 9d. Adding £3541 7s. 9d. for interest on investments during 1921–22 and £11,375 12s. 10d. for the same thing during 1922–23, the final net balances on working amounted to £549,642 0s. 2d. and £675,168 for the two years respectively. The net revenue for the year 1922–23 was therefore greater by £125,525 19s. 10d. than that of the year immediately preceding it. The general result of the year's working was that after meeting all liabilities, including payments of (*a*) £13,674 4s. 7d. to the Paisley District Tramways Company, Limited, being the proportion of the traffic receipts due to it; (*b*) £41,407 odd for interest and sinking fund; (*c*) £40,187 odd for income tax; and (*d*) £6190 odd for parliamentary expenses, and putting the considerable sums of £274,454 11s. 10d. and £264,315 2s. 3d. to the Depreciation and Permanent Way Renewals Fund, there still remained a balance of £20,078 10s. to pay over to the "Common Good."

A feature of the accounts is undoubtedly the considerable drop in working expenses. The percentage of expenses to traffic receipts, which had been 76.88 in 1921–22, fell during the year under consideration to 70.72, as the result of economies in very many directions. The result was achieved in spite of the facts that 13,603,351 fewer passengers—417,769,122, as compared with 431,372,473—were carried, and that only 66,808 fewer car miles—26,957,721, as compared with 27,024,529—were run. Moreover, the average traffic revenue per car mile worked out at 20.051d., as compared with 20.845d. in 1921–22. On the other hand, the average working expenses per car mile, including power works cost and the amount expended on permanent way renewals, only reached 16.141d., as compared with 18.59d. in 1921–22, the average working expenses per passenger being 0.915d. and 1.004d. in the two years respectively. It is of interest to note that the average fare paid per passenger was 1.294d. in 1922–23, as compared with 1.306d. in 1921–22.

The Glasgow Tramways Department maintains five separate funds—in addition to a sinking fund—for various purposes. First of all in point of value is the Depreciation and Permanent Way Renewals Fund. The amount standing to the credit of this fund on May 31st, 1922, was £466,472 3s. 10d. The amount added to it during the year 1922–23 was £274,454 11s. 10d., plus £264,315 2s. 3d. equals £538,769 14s. 1d., while the amount expended during the same period on renewal of track, &c., was £222,731 4s. 3d., so that the amount remaining to its credit at May 31st this year was the large sum of £782,510 13s. 8d. The rates adopted for making provision for depreciation and for permanent way renewal are as follows:—

| | |
|---|---|
| Permanent way, per mile of single track .. | £1300 |
| | Per cent. |
| Electrical equipment of line .. .. .. .. | 6½ |
| Power station and sub-station plant .. .. | 13 |
| Workshop tools .. .. .. .. .. .. .. | 5 |
| Cars .. .. .. .. .. .. .. .. .. | 10 |
| Electrical equipment of cars .. .. .. .. | 25 |
| Other rolling stock .. .. .. .. .. .. | 20 |
| Miscellaneous equipment .. .. .. .. .. | 6 |
| Office furniture and fittings .. .. .. .. | 5 |
| Clydebank bridges .. .. .. .. .. .. | 5 |

Next to the Depreciation and Permanent Way Renewals Fund may be mentioned the General Reserve Fund, which at May 31st, 1922, stood at £22,837 18s. 3d. During the year £205 10s. was added to it and £20 5s. 2d. subtracted from it, so that at May 31st last it stood at £23,023 3s. 1d.

Since June 1st, 1914, the Tramways Department has been carrying its own Third Party Risk. During the year £40,000 was placed to its credit, while the claims and expenses paid in connection with the working of the Third Party Risk during the year was £26,506 17s. 1d. The balance standing to the credit of the fund at May 31st last was £34,334 14s. 6d.

Since June 1st, 1915, the Department has also been carrying its own Employer's Liability and Workmen's Compensation Risk. The fund was credited with £3500 during the year, while the claims and other expenses paid in connection with the working of the Risk amounted to £2694 18s. 6d. The balance standing to the credit of the fund at May 31st, 1923, was £6087 17s. 1d.

Since June 1st, 1916, the Department has also been carrying its own Fidelity Risk. Nothing, apparently, was withdrawn from this fund during the year, but a sum of £225 was added to it, and it stood at £1329 10s. at May 31st last.

Altogether, therefore, the Department had put by at the end of its last fiscal year a sum of £847,286. Since 1896 the sum of £1,301,528 4s. 4d. has been set aside as a sinking fund and applied in liquidation of debt. In February, 1917, a sum of £2,328,889 15s. 4d. was transferred from the Depreciation and Permanent Way Renewals Fund, likewise in liquidation of debt. In fact, at that time all outstanding debts had been paid off, so that the undertaking had no debt at all. Finally, since June 30th, 1894, there has been paid to the Common Good Fund a sum of no less than £1,167,305 2s. 2d. These items taken together reach the huge total of £5,645,009.

There are numerous other points in the report which are worthy of note. For example, the amount set apart for permanent way renewal—£1300 per mile of single track per annum—works out at nearly 2.4d. per car mile. The total number of units of electricity used for traction and car lighting was 42,976,803, and the number per car mile 1.59. The average revenue (*a*) per car-hour was 12s. 5.61d.; (*b*) per mile of single track operated, £10,973; and (*c*) per head of population served, 32s. The average car miles per day per car—thirteen hours' day—were 97; the average speed 7.46 miles; and the average car-hours per day 9898.2. The average number of passengers per car mile was 15.5; the average number of journeys per head of population per year, 296.98; and the average fare paid by passengers, 1.294d. Of the total number of passengers carried 57 per cent. paid ½d. or 1d., 28 per cent. 1½d., and 15 per cent. 2d. and upwards. Of the total traffic revenue, 40 per cent. came from ½d. and 1d. tickets, 32 per cent. from 1½d. tickets, and 28 per cent. from tickets costing 2d. and upwards. The ½d. fare, which conveys a passenger for two stages, is paid by means of tokens or coupons.

## TRIALS OF MARINE OIL ENGINES.

EARLIER in the year we were able to announce that the Institution of Mechanical Engineers and the Institution of Naval Architects were organising a series of trials of marine oil engines and motor ships, and that, with the sanction of the Admiralty, the joint Committee formed had been joined by Engineer-Vice-Admiral Robert B. Dixon, C.B., Engineer-in-Chief of the Fleet.

The first set of engines which will be tested by the Committee has been built at the Hartlepool Engine Works of Richardsons, Westgarth and Co., Limited, and a large company of guests were present on Monday last when the engines were set in motion by Mrs. Dixon, and the official trials begun. It will be remembered that Mr. D. B. Morison, the chairman and managing director of Richardsons, Westgarth and Co., was instrumental in making the first offer of engines for testing, and it is satisfactory to note that in conjunction with Furness, Withy and Co., Limited, and the Furness Shipbuilding Company, this offer includes facilities for testing the completed ship which is now being built at the Tees yard of the last-named company. The vessel is the twin-screw steamer Sycamore, and the machinery installation comprises two six-cylinder four-stroke cycle Diesel engines of the Richardsons-Beardmore-Tosi type, designed to develop about 3000 indicated horse-power at a speed of 125 revolutions per minute. An account of this type of engine, giving details of its construction and illustrating the working of the patented director type of air and exhaust valve, has already been given in THE ENGINEER of November 11th, 1921, and its arrangement in the single-screw motor ship Pinzon built by William Beardmore and Co., Limited, was described in our issue of February 10th, 1922.

We understand that several different types of engines and motor ships have been placed at the disposal of the testing committee, and the results obtained will be awaited with interest, for they include, not only information relating to test bed trials, but also particulars of the actual performance of the ship, including such factors as hull and propeller efficiency, manœuvring trials, and economy under sea-going conditions.

## A PROPOSED RAILWAY THROUGH THE SAHARA.

IN its last sitting the French Superior Council of National Defence discussed the question of the possibility of constructing a trans-Sahara railway, and considered the various plans which have already been drawn up with regard to the route to be followed and the method of traction to be adopted. At the conclusion of the discussion, a resolution in favour of the carrying out of the scheme was adopted. This decision has given rise to a number of discussions and articles on the subject of the best manner in which the idea might be carried out.

Although the lack of water appears to be the gravest hindrance to the work of construction, it is a difficulty which it is thought in some quarters may prove less serious than it at first appears. Only about half the route would be waterless, and for the other half, it is considered that it would be possible to transport modern boring machines on caterpillar-wheeled cars to points where there is reason to believe scientific boring might be successful. In any case, as the line progressed, water could be

transported by it, sufficient for the 1500 workers who would be engaged on its construction.

Sudden and considerable changes of temperature to which desert regions are subject are, however, considered likely to hamper operations, both by reason of the bad effect on the workers and also by bringing about excessive expansion and contraction of the metal used. Another problem calling for careful consideration is that of fuel. It is pointed out that steam engines could not be used unless a supply of water was available all along the line, and to provide it would be very costly. Moreover, it would, it is urged, be inadvisable to make the railway entirely dependent on imported coal or oil, sufficient quantities of which would have to be carried to last the entire journey, or else a part of the traffic of the railway would have to be devoted to the provisioning of depôts at certain points. Electric traction has been considered by one group, which proposes to establish a number of power stations utilising the hydraulic power of certain regions of the Atlas and the Niger.

A suggestion which has received a certain amount of support is a proposal to use engines employing as fuel vegetable oils, which could be produced in close proximity to part of the route which would be covered by the railway. The advocates of this suggestion point out that the progress which is being made in the utilisation of vegetable oils as fuel is such that by the time the line was laid there would doubtless be motors, driven by vegetable oil, powerful enough to ensure regular traffic on the line. Such a solution, it is urged, would give the railway much greater freedom of action than would the employment of any other means of traction.

## Patent Action Damages.

OWNERS of patents often have difficulty in appreciating the value of inventions either from the aspect of what they are worth to manufacturers infringing patents or in connection with their use by Government departments. This particularly applies to engineering cases because of the enormous range within which patented inventions may lie. The territory extends from large machines, such as rolling mills, to small details; for instance, to cartridge cases or other press work produced in great quantities. The cases heard in the Law Courts often give considerable information in respect of patents which have been the subject of litigation. For some years only few patent actions were tried, but the Chancery Court is now receiving more work in this respect, and the corresponding information derived therefrom is necessarily, therefore, augmented.

Among recent decisions, there are to be found two which may be usefully noted; the first especially showing the different views that may be held by various persons.

In this case, which does not deal with any specific figures, the relationship between the inventor and the Air Council is considered. The main patent in question related to improvements in aeroplanes and the like and in particular to the tail gun pit. An action was brought against the Air Council alleging breach of contract, and the plaintiff asked the Court to determine this, declare the patent valid and decide on the question of infringement of the patent. The present law provides that a patent shall have the same effect against the Crown as it has against a subject of the Crown, but it does not state how an inventor is to obtain redress in respect of wrongs committed by or on behalf of the Crown. A practice has sprung up that if a Government department comes into question a nominal defendant is put forward to defend an action on an allegation by a plaintiff that his rights have been infringed, and in this way the matter can be brought before the appropriate tribunal at the High Courts of Justice.

In this particular action the judge held that the Air Council was in the position of the Crown, and was not liable to be sued by action for breach of contract. The terms of compensation, therefore, could not be decided, notwithstanding the fact that the Air Force Act provided that the Air Council might sue and be sued by that name. The Court decided that no order could be made giving the plaintiff the relief for which he asked, but, according to the official reports, the Court of Appeal subsequently came to a different conclusion as regards that particular point, and decided that the action could come to trial on the question of liability without deciding any other matters in the meantime.

The second case which has been indicated dealt definitely with the question of damages. It related to the patents, which are now well known, governing the welding of aluminium by the use of a flux formed from alkali chlorides and alkali fluorides. In previous actions the patents had been held to be valid and infringed. The Taxing Master subsequently gave a certificate as to the amount of damages which he considered should be paid and the Court was asked to revise this. It appears the Master assessed the damages at a certain percentage of the selling value of articles manufactured in the ordinary commercial way; that is to say, articles not manufactured for the Government or for Government purposes. The Master, apparently, did not allow any damages in respect of infringements during the time that licences were in force which contained a clause prohibited by the Patent Act. Further, it was alleged that the Master had not allowed any sum for damages in respect of articles used by the Government during the war.

On the first point the figure allowed was 4½ per cent. on the selling value, and it was a flat rate.

The matter was complicated to a certain extent by the licences, but, in the opinion of the judge, what has to be ascertained is the price which an infringer would have to pay if, instead of infringing the patent, he had come to be licensed under the patent. He came to the conclusion that in this case the Court was not treating the infringer unduly harshly. Interesting figures of royalty were quoted comparing the present figure with that of other licences which had been taken; for example, in one the royalty was at the rate of 10 per cent. in the case of articles of £5 and under, 7½ per cent. in the case of articles between £5 and £50, and 5 per cent. in the case of articles above £50, and it appears that no evidence was given to show that the terms of existing licences were so oppressive that manufacture could not profitably or reasonably be expected to take place under those terms.

The judge came to the conclusion that it was not correct to apply a flat rate licence to articles of quite different classes, and that it would be more accurate to deal with the matter on the basis of an existing licence in which a scale were provided for articles of different kinds. The Court dealt with the question of a licence containing prohibitive clauses in detail, but having regard to the particular facts of the case felt that a sum ought to be allowed for damages in respect of the articles in question, although at the time when they were purchased there were certain contracts in force which had been rendered null and void by the existing Patent Act.

As regards the Government user, there was mentioned an old decision of the House of Lords in which it was held that the right of the Crown to use a patented article or process could not extend to contractors who were employed as contractors by the Government, but in the judgment of the Court the appropriate sections of the present patent laws are primarily agency sections; that is to say, they afford protection to the Government department and to any person or persons acting as agents for them or by their authority. Ultimately, it was settled that damages should be awarded on the basis of royalties provided by an existing licence; that in cases in which the defendants were the direct contractors with the Government the rights of the patentees should be determined by the Treasury—or, presumably, in connection with later matters by the Court—or, if the parties thought fit, by the Royal Commission on Awards to Inventors. It was agreed that the amount of damages found should be £1506 instead of £717, which was the sum found by the Master based on the flat rate 4½ per cent. royalty.

## Letters to the Editor.

*(We do not hold ourselves responsible for the opinions of our correspondents.)*

### THE HERBERT "PENDULUM" HARDNESS TESTER.

SIR,—In the April 13th issue of THE ENGINEER a very interesting apparatus, "The Pendulum Hardness Tester," is described. I give below some theory of the apparatus on the assumption of permanent set of the material under test. It will be observed that the periods of oscillations of the "pendulum" as calculated on this assumption are in good coincidence with the results of experiments given in the paper mentioned above. Consider first oscillations of the "pendulum" on the perfectly rigid plane surface.

Let $e$ denote the distance of the centre of gravity C $g$ of the apparatus from the centre O of the ball, $\theta$ the variable angle of oscillation, Q the weight of the pendulum, and I the moment of

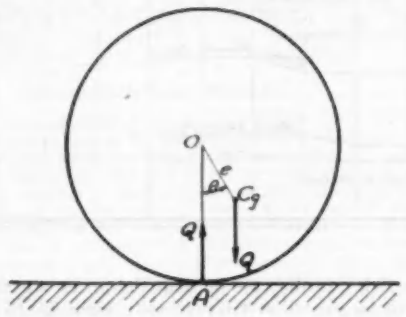
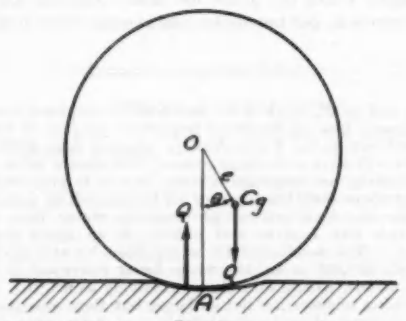



Fig. 1.




"THE ENGINEER" Fig. 2. SWAIN &c.

inertia of the apparatus about the axis through O and perpendicular to the plane of oscillations. Assuming $e$ and $\theta$ are small quantities, the equation of oscillations will be—

$$I\ddot{\theta} + eQ\theta = 0 \quad \ldots\ldots\ldots (1)$$

Using the denotation for the radius of inertia,

$$r = \sqrt{\frac{Ig}{Q}} \quad \ldots\ldots\ldots (2)$$

The period of one swing, from (1), is

$$T = \pi \frac{r}{\sqrt{eg}} \quad \ldots\ldots\ldots (3)$$

i.e., the period of a swing is inversely proportional to $\sqrt{e}$.

The same result may be expected also in the case of a perfectly elastic plane surface as the distribution of pressure over the contact surface at A will be symmetrical about the vertical axis A O. In the case of permanent set the conditions on oscillation represented in Fig. 2 may take place. The distribution of contact pressure is no longer symmetrical about the vertical axis O A and the arm of the couple of forces Q depends, not only on the excentricity $e$, but also on the maguitude of permanent set. Assume that at oscillation the arm of the couple varies as

$$(e + \delta) . \theta,$$

where $\delta$ is a constant depending on the permanent set. Then the equation of oscillation is

$$I\ddot{\theta} + (e + \delta)Q\theta = 0 \quad \ldots\ldots\ldots (4)$$

The period of a swing will be

$$T = \pi \frac{r}{\sqrt{(e + \delta)g}} \quad \ldots\ldots\ldots (5)$$

The period decreases with the increasing of $\delta$, *i.e.*, with the increasing of permanent set.

We see that the oscillations can be produced also with a negative value of $e$, *i.e.*, with the C $g$ above the centre O of the ball; it is necessary only that $e < \delta$.

Let us apply formula (5) to the results obtained in the experiments with glass (see Fig. 3 of the paper, p. 390). Comparing the results obtained for $e = .3$ mm., and $e = .05$, formula (5) gives

$$\delta = .0137 \text{ mm.} \qquad r = 10.6 \text{ cm.}$$

With these values of $\delta$ and $r$ the period T for any value of $e$ can be calculated from (5). Some results obtained in this manner are given in the table below.

| $e =$ | .05 | .1 | .15 | .2 | .3 |
|---|---|---|---|---|---|
| 10 T as calculated from 5 .. | 133 .. | 109 .. | 83 .. | 72 .. | 60 |
| 10 T as obtained from test . | 133 .. | 100 .. | 81 .. | 70 .. | 60 |

We see that formula (5) is in good agreement with the results of experiments.

Applying the same formula (5) in the case of high-speed steel (Fig. 3 of the paper), we obtain from the experiments ($e = .3$, $e = -.1$), $\delta = .188$ mm.

The results calculated from (5) with $\delta = .188$ and $r = 10.6$ cm. are given in the table below.

| $e =$ | — 0.1 | 0 | .1 | .3 |
|---|---|---|---|---|
| 10 T as calculated .. .. | 113 .. | 77 .. | 63 .. | 48 |
| 10 T from the test .. .. | 113 .. | 76 .. | 63 .. | 48 |

Again, a good agreement of formula (5) and of experiment is obtained.

When the centre of gravity of the apparatus is above the centre of the ball the formula for calculating T is

$$T = \pi \frac{r}{\sqrt{(\delta - e)g}} \quad \ldots\ldots\ldots (6)$$

It is easy to see that when $e$ approaches $\delta$ the apparatus becomes very sensitive. A small variation of $\delta$, *i.e.*, a small variation in permanent set, will produce a great effect on the period of oscillation T.

S. TIMOSHENKO.

Research Department,
Westinghouse Electric and Manufacturing Company,
East Pittsburgh, Pa., June 14th.

### STARTING AND ACCELERATING PECULIARITIES OF ELECTRIC ROLLING STOCK.

SIR,—The writer, in going about his duties in the rolling stock department of a large North Country tramways system, has been struck by some peculiarities in the starting and accelerating properties of tramcars.

A tramcar, when driven from one end, behaves in a manner on the road such that, when driven from the other end, the starts from rest are similar to those experienced as between two different vehicles. At one end driving wheel slip takes place, acceleration is slow and jerky, whilst movement on hills, curves and greasy rail is a matter of difficulty and only accomplished by the use of sand. When driven from the other end, starting is easy; hills, curves and greasy rails present no difficulty; sand is not needed, whilst acceleration *is* smooth and uniform.

A tramcar, like other electric rail vehicles, is propelled by two or four motors. The weight of the vehicle is evenly distributed over the driving axles, and from the construction and fittings of the vehicle it is difficult to find any reason whereby one start from rest in one direction differs from a dead start in the other direction. Our electrical *confrères* would say that so far as is known each motor does its share of the work in propelling the vehicle. This is quite true on paper and on the test bed; but, on the other hand, if a motor runs away in one direction of car operation and does its work well and without slip in the other direction, it shows that paper calculations and test bed data do not square with operating practice.

The writer, in conjunction with two colleagues, began to investigate these peculiarities, and eventually came across a reason for them which is simple in itself but rather difficult of explanation, and is perhaps opposed to text-book theories.

When a tramcar was running in the direction when wheel slip was evident, it was observed that this condition appeared on the driving wheel of the leading bogie only, and this appeared to be because the weight of the car was being pulled from the front end, whilst the greater part of the car weight would be at the rear of the front bogie and pushed by the motor on the rear bogie. From this it was assumed that two traction motors in series do not do the same amount of work, and that the motor driving the slipping driving wheel consumes more current than its neighbour does. The direction of travel when there was no wheel slip was found to be that when the first motors of any two in series was at the rear of the car.

A car has been re-wired as an experiment, so that whichever way it runs the current flow has been arranged so that the first of any two motors in series is at the rear of the car, and this vehicle has given very satisfactory results. This arrangement brings up the old-time theory of push *v.* pull, and so far as electric traction is concerned the "push" system is working very much more economically and satisfactorily than the "pull" arrangement. The experiments are still proceeding. As a peculiar motor defect of interest to mechanical engineers engaged in electric traction work, this defect appears on the commutator of No. 2 motor of any pair of motors in series, and has been noticed as occurring at the moment of change from series to parallel when No. 1, the slipping motor, is at the leading end of a vehicle. This defect may have something to do with momentary heavy "push." The experimental car with both ends "pushed" does not show this motor defect, and subsequent investigation may disclose some useful information to traction men.

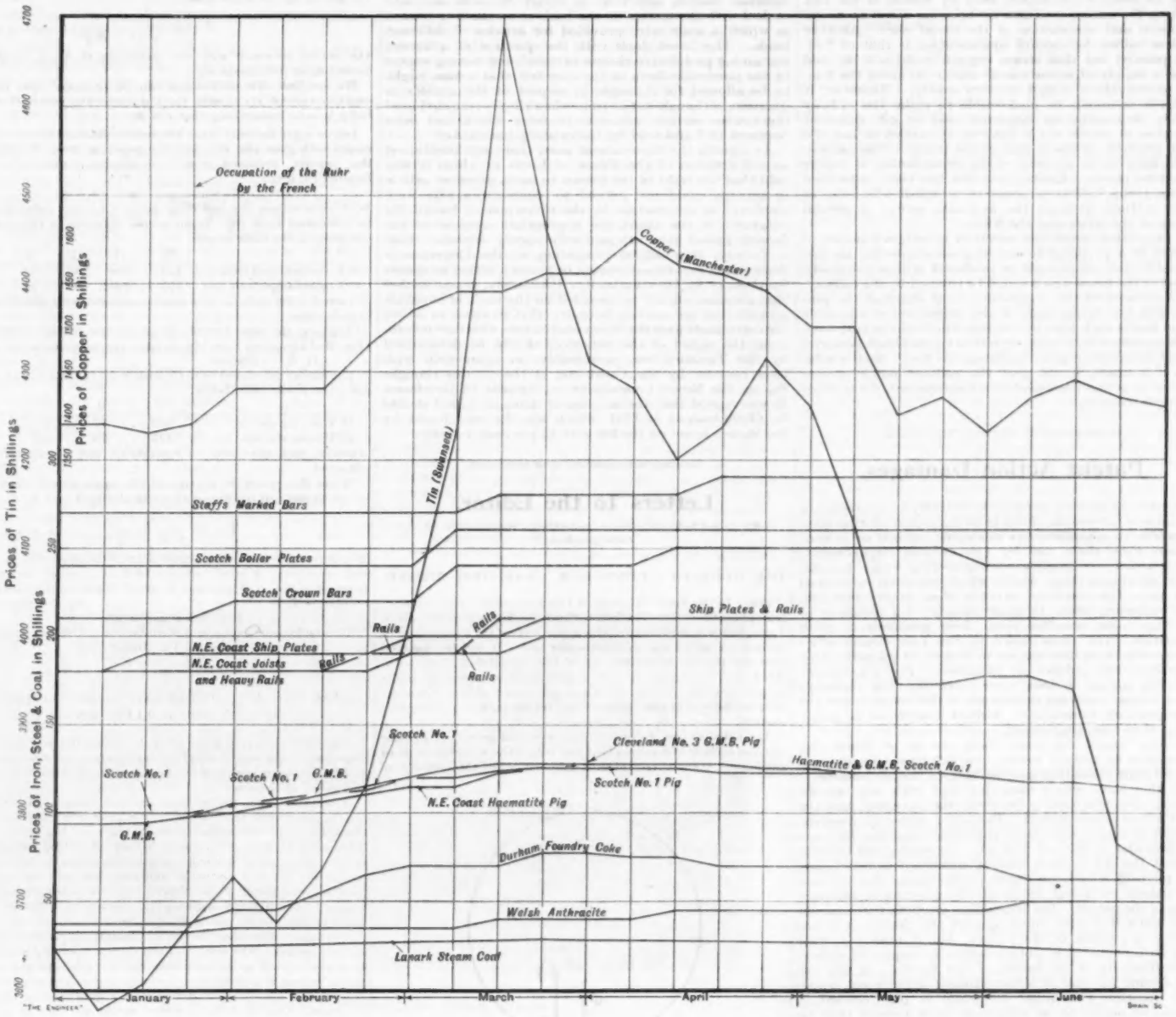
We all know how easy it is to push a barrow. The action of railway trains pushed by a banking engine is a good start and quick acceleration. Front drive motor vehicles are not altogether satisfactory. Electric trains with a motor coach in the rear accelerate better than when two motor cars are at the head of a train, and a disabled tramcar is easily pulled, but pushed with great difficulty.

The writer has to thank his colleagues, Messrs. Edwards and Etheridge, for their help, and would be glad to know the views of other traction engineers.

J. AUSTIN BAKER, A.M.I. Mech. E.

Ashton-on-Mersey, June 29th.

## PRICES OF ENGINEERING MATERIALS DURING THE FIRST HALF OF 1923




The prices are all given in shillings. It should be noted that separate zeros are given for tin and copper, while the scales for these two metals are different from those for other commodities. The horizontal divisions are weeks, taken from Friday, January 5th, to Friday, June 29th. In the case of coals the prices are those quoted for export, as it is practically impossible to give market prices for industrial consumption at home. Thus in South Wales the prices for inland consumption are sometimes 2s. per ton above, and at other times as much below, export prices. In Scotland the pithead price is generally some 2s. below the f.o.b. price, but carriage costs from 4s. to 7s. 6d., according to the distance. In the Midlands home prices are generally from 2s. 6d. to 4s. per ton less than those for export.

## Indian Engineering Notes.

(*From our own Correspondent.*)

BOMBAY, June 16th.

### Hyderabad State Railways.

A CONSIDERABLE amount of railway construction work is proceeding in Hyderabad State, where 167 miles of new track have recently been completed out of State revenues and a further 190 miles are under construction. When these lines are completed, the total mileage in the Nizam's Dominions will be 1288, of which 718 miles will be owned by the N.G.S. Railway Company, 213 by other companies, and the remainder by the State. The major portion of the new construction is metre gauge, but it may be noted that several sections of broad-gauge line have been added in the colliery areas on the eastern frontier of the State, thus giving increased facilities for the carriage of coal *viâ* the Bengal-Nagpur Railway to Calcutta. Incidentally, there is an interesting proposition to construct a mixed gauge line between Ligampalli and Hyderabad, with the object of dealing with both broad-gauge and meter-gauge rolling stock repairs in central shops at Lallaguda. Considerable progress has also been made with the line which will link Secunderabad with Karnul, and thus give direct metre-gauge connection through Hyderabad State from Manmad on the Great Indian Peninsular Railway to South India, but this, like several other lines in the State, is held up pending the provision of funds for bridging wide rivers.

### Irrigation Projects.

In addition to the expenditure on railways, Hyderabad State is also spending immense sums of money upon various irrigation projects and upon roads. During the past year, according to a report issued a few days ago, the expenditure upon irrigation alone amounted to no less a sum than £130,000, this sum being spread over 476 projects, large and small, of which 87 were finally completed during the year. One of the most important projects is being carried out in the Purna Valley, where a dam 162ft. in height will serve a drainage area of 2700 square miles. It is primarily an irrigation scheme, but it is proposed to utilise about 6000 horse-power for hydro-electric purposes by the simple expedient of dropping water from the reservoir into a river and picking it up again downstream. The total area to be irrigated by this project exceeds 480,000 acres, the water being conveyed in two main canals, 35 and 80 miles respectively in length. The remaining schemes are not so large, but they incorporate several dams of no inconsiderable size. As regards communications, the State is already fairly well served by roads, which total over 24,000 miles in length, but, nevertheless, a large amount of new construction is being pushed forward. The most notable new road is that which will connect Hyderabad with Sholapur, a distance of 175 miles, where it will link up with the main route between Madras and Bombay.

### Hydro-Electricity in Ceylon.

It is announced that the whole question of utilising water for power purposes in Ceylon is to be submitted to an expert committee appointed by Government. It will be recalled that the Government of Ceylon's hydro-electric scheme was framed as a result of suggestions put forward at the annual meeting of the Engineering Association of Ceylon in 1918, and after a great deal of discussion in the Legislative Council, several officers of the Public Works Department were deputed to study hydro-electric developments in Europe and America. These officers have now completed their investigations, and it is anticipated that one or more sites will be developed as soon as the Committee has concluded its inquiry. The power in sight amounts to nearly 200,000 electrical horse-power, and of this amount 70,000 could be developed at one site on the river Mahaweliganga, in the middle of the island, and 50,000 at the Kitulgala Rapids, 42 miles from Colombo. It is expected that the most important application of water power will lie in the electrification of railways, for which a comprehensive scheme has already been prepared. It is interesting to note that while the big scheme is still in the making, many of the smaller towns have installed electric generators driven by oil engines. According to present arrangements, these generating sets will be transferred to more remote towns when electrical energy derived from water power becomes available.

### Sukkur Barrage.

After many years of vacillation and delay, work upon the Sukkur Barrage project has been definitely commenced, funds for the purpose having been voted by the Bombay Legislative Council a few days ago. The barrage will be the greatest work of its kind in the world, measuring 4725ft. between the faces of the regulators. It will consist essentially of a masonry floor across the river Indus at a level somewhat lower than the average level of the river bed, above which a double overbridge of sixty-six spans, each of 60ft. width, will be constructed, and the flow of water will be regulated by the raising and lowering of massive iron gates. These gates will be operated from the upper, or "gate" bridge, whilst the lower platform will provide a road across the river. It is anticipated that the barrage will be completed within seven years, and the canals, which will give perennial irrigation to 5½ million acres, within eleven years. The total cost is estimated at £18,500,000, and it is calculated that the project will show a return of 6.2 per cent. in the second year after completion, this figure rising steadily to 14.6 per cent. within forty years of the commencement of the work.

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As from July 9th the 10 a.m. from Euston by the West Coast route will once more be due in Glasgow and Edinburgh at 6.15 p.m.—the timing in operation when war broke out.

# Provincial Letters.

## THE MIDLANDS AND STAFFORDSHIRE.

*(From our own Correspondent.)*

### Market Still Depressed.

THERE has been no change of note in the market situation in the Midlands and Staffordshire during the week. Business is as depressed as ever, and orders are practically unobtainable. The abstention from buying has a depressing effect on values, which are generally weaker, especially as regards raw iron and steel. Old orders have been worked off to a great extent, and the dearth of fresh business has meant a general slowing down in the works. In most departments competition for the few orders which come on to the market is extremely keen, and many instances of underselling are spoken of. This accentuates the instability of prices. Continental competition in both semi-finished and rolled material is an important factor in the situation. Though during the week Belgian quotations have advanced by something like 7s. 6d. per ton, they are still so low that Midland iron and steel masters, even if they were prepared to sell at cost price, would have little chance of capturing the business. Generally speaking, mills in this area are holding their own better in regard to half products than in rolled material. Larger consignments of continental material are coming into the district against old contracts.

### Lower Raw Iron Prices.

Pig iron prices have declined still further this week, both Northamptonshire and Derbyshire brands being obtainable at about half-a crown less than was the case a week ago. Nominally, quotations have not altered much, but what business has been put through has been, for the greater part, at the reduced rates. There is a marked difference between the prices quoted by smelters and those which they are prepared to accept for actual business. Forge material has been practically neglected of late, and only small lots of foundry material have changed hands. Consumers state that they have been offered Northamptonshire forge at less than £4 10s., but that figure marks the general level. A small export order for Derbyshire No. 3 foundry is stated to have been put through at £5, though most makers continue to ask £5 2s. 6d. for home business. Northamptonshire foundry has been offered in many cases at £5, and lower prices, it is believed, would be accepted for a forward contract, but this class of buying is out of the question for the time being. Smelters are loth to create stocks, which might have to be realised at prices that bear little relation to present costs. Many Midland furnaces, fortunately, still have orders unexecuted, and in some cases can dispose of their output for about two months. Up to the present, stocks in this district are reported to be quite small. The Staffordshire works are calling for little pig, and the quietness which usually exists at this period of the year, when works are stocktaking, is accentuated.

### Staffordshire Bar Iron.

The Staffordshire bar iron works continue badly off for orders, and operations are being restricted to isolated mills at various works, while in some cases the plant is wholly at a standstill. Business remains extremely quiet, and there is little or no new work forthcoming to take the place of orders which are rapidly being worked off. Consumers keep up persistent pressure for additional price concessions, and to some extent have worn down the resistance of producers. But production costs are so high that substantial reductions cannot take place until these are lowered. Prices have reached a level which leaves little or no margin of profit, but the volume of trade continues to shrink. Marked bars alone have withstood the pressure, but some readjustment of the £14 10s. standard is not improbable. This branch, which is largely special to this district, is not subjected to the same keen competition as the unmarked bar branches. For the best Crown bars some Staffordshire firms, whose products are held in especial esteem, still ask £12 10s. This is no indication of the general market position, however, for £12 is the usual quotation at date, and ordinary merchant iron is said to have been offered as low as £11 15s., and even £11 10s. is mentioned. Demand for nut and bolt bars is very quiet, and the Staffordshire makes at £11 have only a very poor chance with Belgian bars obtainable at £8 17s. 6d. delivered here, even though the latter price is well above the figures recently quoted. Lancashire makers continue to ask £11 5s. for this class of bar and £11 7s. 6d. for fencing iron.

### Galvanised Sheets.

Galvanised sheets at the reduced price of £8 10s. are in fairly good request. Consumers have been waiting for weeks past for a reduction equivalent to the fall in the price of sheet bars and spelter, and now that concessions have been made by sheet makers, they are renewing buying to some extent. The mills are for the most part comfortably off for work, and are still taking orders steadily. Black sheets are in fair request at £13 10s. for motor-building requirements and other purposes.

### Raw Steel Prices Reduced.

Raw steel prices have fallen to the extent of 5s. per ton, sales of sheet bars and billets having this week been effected at £8. Several of the large steel works decline to follow the reduction, stating that the selling price now barely covers the cost of production. Others have given way only to the extent of half-a-crown, quoting £8 2s. 6d. Consumers are not satisfied even now, and continue to ask for lower prices. Belgian semi-finished material having been advanced 5s. per ton to £7 15s., strengthens the hands of local producers. The seller's price of £10 10s. for Staffordshire steel bars does not indicate the extent of the subsidence in this material. Mild steel rods are quoted at date £12 5s., but continental offers are being received of this material at £11 5s. delivered. For finished steel, prices are not being materially reduced, the manufacturers regarding the margin of profit as irreducible. Belgian finished steel is being shipped from Antwerp to various foreign destinations at £7 17s. 6d. f.o.b. to the orders of Birmingham merchants.

### A Bright Spot.

The wire branch is the bright spot in the steel industry. It is a conspicuous exception to the general downward movement. The mills have been well occupied for some time past and continue so to be. The Association has lately advanced its prices to £18, as compared with £15, which was the general figure on contracts terminating at the end of June. It is thought that the increase in the price of wire will give an opening to Canadian competition, large makers in the Dominions having lately been sounding the market.

### Improved Coke Position.

The tone of the coke market is easier, and consumers count upon getting much better terms in the near future, provided there is no fresh diversion in connection with the situation in the Ruhr Valley and the trade arteries connected with it. There are now spot lots of coke to be had in rather greater freedom. Prices have touched as low as 28s., but rather more is wanted in most cases. Owners of blast-furnaces state that unless they get definite relief in the fuel bill there will be a drastic curtailment of output.

### Nuts and Bolts.

Mr. Edward Steer, chairman and managing director of Guest, Keen and Nettlefolds, Limited, at the annual meeting of that company last week, referring to the nut and bolt industry, said that the trade had been passing through a period of unprecedented depression. The productive capacity of the works engaged in the trade had been at least equal to double the demand, with the result that manufacturers had been quoting ruinous prices to secure work, and the industry had drifted into a deplorable condition. He announced that with a view to the further consolidation of the position, his company had recently acquired the whole of the share capital of three of the oldest Darlaston firms, Horton and Sons, Limited, Enoch Wilkes and Co., Limited, and James Simpson and Sons (Bolts and Nuts), Limited, the reconstruction of which works was now being planned.

### Wages Increase for Cannock Chase Miners.

The Wages Board for the Midland area has this week notified the new ascertainment for miners' wages on Cannock Chase for the months of July and August. As anticipated, this shows an increase, but it is smaller than had been hoped for by the men, being only 4.04 per cent. This is equivalent to 3d. a day for stallmen, who during May and June have been getting 10s. 2d. a day. The new minimum becomes 10s. 5d. a day. There are proportionate increases for other classes of colliery workers.

### Unemployment in the Midlands.

Following upon a slight increase in the unemployment returns for the previous week, the latest returns for the Midlands fortunately again show a welcome, though small, decrease. For the week ended June 25th the number of workless was 154,865, as compared with 155,427 for the previous week, a decrease of 562. In Birmingham the number of persons out of work was 41,849, as compared with 42,168 a week earlier, showing a decrease of 319. The number of unemployed in the principal towns is now:—Coventry, 4097; Bilston, 3559; Cradley Heath, 4366; Dudley, 4421; Smethwick, 5399; Stourbridge and Brierley Hill, 3283; Walsall, 6116; West Bromwich, 3776; and Wolverhampton, 7741.

## LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER, Thursday.

### General Outlook.

LAST week one was inclined to think that the feeling of depression in the metal trades, and particularly in iron and steel, had reached its limit. People were saying that things could not be, and had never been worse, but in every depth there is a lower depth, and this Miltonic truth is being illustrated in the metal trades to-day. In some departments of the metal industry there does not seem to be any room for a fall in prices; but there is certainly room for much lower prices yet in pig iron, billets, fuel and raw material generally. The trouble is that the fall is occurring in pig iron before it occurs in coke, and is causing very much inconvenience in consequence. Nevertheless, there is now a chance that furnace coke will soon be cheaper, for the causes which led to the rise during the last four months are rapidly dwindling in intensity, and makers of iron and steel are hoping that they will soon be relieved from the trouble of excessively dear fuel.

### Metals.

The dulness in the copper market has been very pronounced, and a good many people are now again anticipating lower prices. This is, however, a common feature in the market after a period of depression, and very often it precedes a sharp reaction. One cannot help thinking that the fall in copper has gone quite far enough, and that the time is coming when the movement will be in the other direction. Standard copper has been moving slowly downwards since the end of March. There have, of course, been interruptions, but the general tendency has been in one direction, and the total fall reached nearly £12 per ton in the standard market. Makers of copper sheets, rods and bottoms reduced the prices by £2 per ton, viz., to £98 for sheets and rods and £108 for flat bottoms. The policy of keeping bottoms £10 above sheets is still persisted in. Meantime, copper braziers, 4ft. by 4ft., for the Indian market are offered at £86 10s. There seems to be some hesitation about reducing the tube prices proportionately. Looking back to the time when standard and refined ingot copper were approximately at to-day's prices, we find that the official prices for manufactured copper and brass were from £2 to £4 per ton cheaper than they now are. It is, however, possible that before these lines are printed some concession may be made in the locomotive and condenser tube prices. The depression in the scrap trade is very pronounced just now. Dealers find only a restricted market in which to sell, and are averse from increasing their stocks. The prices now offered by the dealers for good lots of old metal appear outrageously low, say, about £45 to £46 per ton for gun-metal scrap and about £61 to £62 for clean copper. These are buying prices, of course, and the consumer would have to pay rather more. There is certainly a reaction due in the tin market, but apparently buyers are waiting for the Americans to come in again. One would say that the price to which tin fell at the end of last week was low enough to tempt American buyers. If so, we may see the results during the present week. The total fall since the highest point last March is about £50 per ton. Spelter and lead have both been rather weaker markets. The latter, of course, is bound to be cheaper in the end, but no one can say when. Both merchants and consumers have been anticipating a fall for a very long time. Spelter seems to be under the influence of the large output in America. It is said, however, that galvanisers here are now large buyers.

### Pig Iron.

The markets here for all kinds of pig iron remain very dull and weak, and prices are a little uncertain. Ostensibly there has been no change, but it is clear that sellers are getting nervous at the long period of inaction and the indifference shown by consumers. There is now a tendency for the difference between forge and foundry pig iron to widen again, but this does not mean that the prospects for foundry iron are any better. The theoretical price for Derbyshire No. 3 pig iron is based on 102s. 6d. at the furnaces; but it is generally understood that 2s. 6d. less would be accepted. The foundries here, however, are waiting for much more drastic reductions. One hears talk of blowing out some of the Midland furnaces rather than sell at lower prices, which would mean a loss at present costs; but one doubts very much whether such a measure will be taken. It is only recently that some of these furnaces were blown in, and it would be disastrous to put them out of action so soon. The price here for Scotch foundry iron is a little easier again, but although it is not so extravagantly above common iron as it was, yet founders here try to do without it whenever they can, and the amount used in the Lancashire district is very much smaller than it used to be. The price delivered in Manchester to-day is about 125s. per ton, or perhaps 126s. 3d.

### Steel.

The condition of trade in the steel section of the market does not show any improvement. Some merchants report it as rather duller; but as they were saying last week that there was no trade, one cannot see how it can be worse this week. The prices quoted are about the same as they were, but, of course, inquiry is very scarce and resulting business scarcer. Foreign steel is still offered here at from 30s. to 35s. per ton below the British prices.

### Scrap.

Dealers in old iron and steel are in much the same depressed state of mind, and report that selling is a very arduous task just now. The foundries are buying very little cast scrap, although it is cheap compared with pig iron. Very good lots can be obtained at 85s. per ton, and there are reports of sales at 80s. The malleable iron-works are now offering only 85s. for heavy wrought scrap, probably because work is now so scarce that they are not in need of it. The value of heavy steel melting scrap in Lancashire seems still to be about 70s. per ton on trucks.

BARROW-IN-FURNESS, Thursday.

### Hematite.

The condition of the hematite pig iron trade is unsatisfactory. For some weeks it has been going from bad to worse, and now makers are compelled to put furnaces out. The other week one was put out at Cleator Moor and now one has gone out at Millom and one at the Barrow works. Trade shows no signs of improving. Once there was a good demand from America and some pretty big cargoes were shipped, but now the demand is very small. Again, the home trade was good, and some time ago consumers placed pretty substantial forward contracts. Now they are adopting the from-hand-to-mouth policy, and this looks like continuing for a time. As the steel trade, generally speaking, is dull, the local consumption of iron on that account is small, and this is leading to restriction of output. Orders held for forward delivery are dwindling, and there are not others to take their places. The continental trade is not heavy, nor is it expected to be. There is a general uneasiness in the trade, and prices are to a certain extent uncertain. To a certain degree, the price of coke is operating against pig iron makers, who are finding it difficult to make a margin at present costs, and until there is an easing in the price of this fuel the price of iron will naturally be affected.

### Iron Ore.

The iron ore trade is feeling the effect of the setback to the iron trade, and not many of the Furness mines are busy. Yarlside may probably close. The Cumberland mines are better engaged, and the one owned by the Millom and Askam Iron Company is shaping at proving a most extensive property. Still, even in Cumberland the pinch is being felt, and there is not the same activity. Foreign ore is coming in, but a great deal is being stored on the dock side at Barrow.

### Steel.

The steel trade is moderate. The Barrow rail

mills are fairly well employed, but no great orders are held. Several cargoes of rails and fish-plates have gone coastwise from Barrow for transhipment at Liverpool. The hoop mills are better circumstanced, and there was a shipment to New Orleans last week. The small bar mills are fairly well employed. Shipbuilding and engineering are suffering from the boilermakers' dispute. Foundries are not brisk.

## SHEFFIELD.

*(From our own Correspondent.)*

### Steel Trade Falling Off.

THERE is no longer any doubt as to the growing slackness of work in the heavy steel-producing departments of Sheffield and district. The absence of new orders, which has been a feature of the situation for several weeks, continues, and the great ranges of open-hearth furnaces, which have for the greater part of this year been turning out steel in thousands of tons per week, are getting short of work. The biggest range of all—that of Steel, Peech and Tozer at Templeborough, near Rotherham—is at present closed on account of the half-yearly stocktaking, and the prospects of a full resumption at an early date are by no means good. The working arrangements will depend upon the booking of new business. In addition to financial stringency and lack of confidence, continental competition has again been making itself felt as a factor which prevents the placing of business. Steel billets from the Continent have been offered at cut prices, and Sheffield makers say they are unable to bring their prices down, owing to the high cost of fuel and raw material. The foreign competition is, however, believed to be waning, and if this should prove to be the case, the demand for home products will again be stimulated. The outlook is not pleasant, but several leading authorities refuse to regard it as one of unrelieved gloom. They believe that there will be a return to comparative activity before very long.

### A Cheery Note.

The official journal of the Sheffield Chamber of Commerce, for instance, while agreeing that the Sheffield and Rotherham heavy and medium trades are working off their current contracts faster than they are booking new business, maintains that the outlook is not quite so dark as some people imagine. "The general world steel shortage continues," it says, "save in America, and United States prices remain high, and as there is no sign of any substantial increase in the output, or further decline in the price of continental iron and steel in the near future, it may be that buyers will be constrained to place orders in this country shortly."

### Not Much Profit in It.

Whether the trade that is being done, or the new trade that is to be done, is of a profit-producing character, is another matter. It is becoming increasingly clear that the making of steel, which is sent out in a semi-finished state for commercial use, is a very poor proposition commercially. "The real fact," said Lord Aberconway at the annual meeting of John Brown and Co. last week, "is that there is very little money at the present day to be looked for in steel production." Mr. Charles Markham, chairman of the Park Gate Iron and Steel Company, on the following day, went further, and said that he did not think there was a steel works in Great Britain to-day that was making both ends meet. The future, he added, was as thick as a bag in front of him. He gave some startling figures to show how the company had suffered during the past year. The directors, in their report, had stated that the works were fairly well employed, and outputs satisfactory, but to obtain orders they had had to make sales below cost. Mr. Markham supplemented these remarks by stating that the output was a record one of 159,000 tons of ingots, but the price obtained for them was only £1,141,000, whereas in 1921, with a make of 150,000 tons, the sales amounted to £2,650,000.

### Some Bright Spots.

There is still a good deal of activity in the railway steel plants, and much work is in prospect. The makers of wire and rope are doing pretty well, and the large wire rod mill at Templeborough has a good order book. The rolling mills of the city have enjoyed a considerable measure of activity. Although they had had little to do for a long period on the ordinary good-class steel for which Sheffield is chiefly noted, they had been able to gain a substantial amount of work on the cheaper steels for the export trade. There is little or no profit in this class of business, however, as prices have had to be severely cut. There is a fair amount of work in some engineering branches, particularly on the lighter side.

### The Lighter Trades.

The crucible steel trade shows some improvement, but is still in a very backward condition on the whole. The majority of the melting holes have been idle for several years. The volume of orders shows some increase lately, but most of the individual placings are on a small scale, and the business is irregular and unevenly divided. The demand for edge tools keeps up well. There is hope of an early reopening of the Russian market on a substantial scale. Finance stands in the way, as sellers naturally insist on doing business on a strictly cash basis. Money is now being provided by the sale of several Russian cargoes which recently arrived in this country, and it is believed that orders will soon be placed and will be large enough to provide a good deal of work for several local firms. The requirements of Russia in saws, files, agricultural implement parts, and other products of the lighter steel trades are enormous.

### A Fine Rolling Mill Contract.

A capital item of engineering news has come forward this week in the announcement that Davy Brothers, Limited, have secured a contract for the supply of new plate mill plants for the Consett Iron Company. The order includes a 40in. electrically driven "Davy" slabbing mill, with a universal manipulator; 44in. by 12in. steam hydraulic slab shears, &c.; 32in. by 6ft. 6in. electrically driven "Davy" three-high light plate mill, with deflecting tables; 42in. by 9ft. 6in. electrically driven two-stand reversing heavy plate mill; and the whole of the handling equipment for the plate-finishing department. The mills to be built are of the universal rolling mill type, by which the bloom is automatically fed in and out of a series of rolls until it is reduced to the finished product, with the intervention of scarcely any hand labour, except that of the first and last operations. The order is probably the largest single one for rolling mill machinery ever placed in this country. It will suffice to keep over 1000 men fully employed for a year, while in the works which supply some of the material another 500 men will benefit. Another order of interest to Sheffield, though not so directly affecting the city, is one for a Metropolitan-Vickers impulse turbine, to be fitted to a large destroyer which is being built in Japan by the Uraga Dock Company. The order has been placed with Vickers Limited, at Barrow, and the work will be carried out at the Trafford Park Works, Manchester, and at Barrow. The twin-screw turbines will develop 39,000 shaft horse-power.

### The Cutlery Trade.

There is very little liveliness in the old staple industry of Sheffield. In fact, things seem to be going from bad to worse. In the case of a good many firms, which were doing moderately well up to a fortnight ago, the reports now are that bookings have markedly fallen off. There are a good many large orders about, but they are only for the cheapest lines, and the necessity of reducing production costs is leading to the adoption of several new devices. One of these is the fitting of a stainless blade into a bolster of cheaper material, whereby the expense of the tang is saved. "Run-on" bolsters are also being used in connection with stainless knives. There is little activity in pen and pocket knives and scissors, in which very severe German competition has to be encountered. The old-fashioned razor trade makes no progress. It has been very bad for a long time, and appears to have received a deep and lasting wound from the safety razor.

### Distinctions for Sheffield Men.

The Birthday Honours published this week gave great pleasure to Sheffield commercial circles by reason of the inclusion of Mr. Arthur Balfour among the new Knights. Sir Arthur has long been one of the leading commercial men in the city, as well as in the country at large. He has been Master Cutler, and President of the Chamber of Commerce, and he very ably headed the deputation which the Chamber sent to America to plead the case—both Sheffield's case and the United States case—against the prohibitory duties of the Fordney Tariff. He is now the President of the Associated Chambers of Commerce, and the knighthood which he has received is a well-merited recognition of valuable public work, much of which, done on behalf of the Government during the war, is of a character which has not become generally known. Another distinction which has given much gratification in the city is the nomination of Sir William Ellis for the presidency of the Iron and Steel Institute. Sir William, who has accepted the nomination, is the managing director of John Brown and Co.'s Atlas Works, Sheffield. He is an engineer by profession, and has also, through his work at Messrs. Brown's, been brought into close touch with some of the most advanced steel problems which have been dealt with in Sheffield, so that he has acquired a considerable knowledge of the metallurgy of the steel industry. He held the office of Master Cutler four years in succession. He does not take up his presidential duties until May, 1924, but he is arranging to make one of a party which is visiting Italy in September next, so as to have the opportunity of meeting many of the members of the Institute and the principal metallurgists of Italy.

### Electrical Progress.

During the year 1922–23 the Rotherham Corporation electricity undertaking made more progress than in any previous period of its existence. The total number of units sold was 39,613,426, an increase of 21,697,517 on the previous year. The engineer recommends a reduction in the selling price for power and heating purposes, from 75 to 50 per cent. above pre-war charges, and for lighting from 50 to 25 per cent. above pre-war. These concessions represent relief to the consumer to the extent of £30,000 per annum. At Retford the Town Council has decided to apply, through the Electricity Commissioners, for a special order authorising it to supply electricity for public and private purposes within the borough and the rural district of East Retford.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

### Trade and the Ruhr Situation.

A REVIEW of the course of trade during the first half of the year affords some ground for satisfaction, though recent events seem to have plunged it once more into the depths of depression, and the outlook is anything but encouraging. During the past six months the staple industries of the North of England have passed through two swift phases of boom and slump. In the early months the Ruhr invasion had the effect of creating an extraordinary demand for iron, and some of the makers sold the bulk of their output for months ahead. The price of the standard quality rose rapidly from 91s. to 125s. per ton, but eventually the advance carried all the evils of rapid inflation in its train. It stifled the demand, assisted to drive up the costs of production, and now ironmasters are vainly trying to get prices back again to a figure which consumers can afford to pay. The Ruhr occupation has undoubtedly had a very serious effect upon British industry. It has, of course, eliminated foreign competition to some extent, but it has also largely reduced foreign consumption, and consequently restricted our foreign trade. Moreover, it has driven up the price of fuel to a level which completely disturbs the economic balance. The outcome is that the June exports of pig iron are less than one-third of those in March last, and a further decline is expected in the future.

### Iron and Steel Exports.

The exports of iron and steel from the Cleveland district during June totalled 77,623 tons, as compared with 86,042 tons in May, a decrease of 8419 tons. The shipments of pig iron amounted to 25,874 tons, of which 17,597 tons went to foreign ports. America received 5545 tons, Germany 4240 tons, France 1275 tons, Canada 1100 tons and Belgium 1031 tons. The exports of manufactured iron and steel during June reached 51,759 tons as compared with 53,575 tons in May. India was the largest customer with 12,448 tons, whilst Canada received 3818 tons, Japan 2979 tons, Nigeria 2719 tons, Victoria 2286 tons, Egypt 1455 tons, and the Argentine Republic 1369 tons. The exports of iron and steel for the half-year just closed totalled 551,792 tons, an increase of 74,168 tons, compared with the total for the first half of 1922. Pig iron shipments totalled 261,126 tons, and those of manufactured iron and steel 290,664 tons. Germany took approximately 50,000 tons of pig iron in six months, whilst the export trade has been materially helped by the big demand from the United States and Canada, Transatlantic customers taking about 42,500 tons. The improvement in manufactured iron and steel trade is chiefly due to the cultivation of the markets in our Overseas Dominions, particularly Australia and South Africa.

### Cleveland Iron Trade.

A rather more hopeful feeling prevails in the Cleveland iron trade. There are a few more inquiries in the market on home and export account, and although these may not at once materialise in business, they indicate more interest in the position on the part of buyers. The latter have been holding out for a long time, but they cannot but recognise that pig iron prices have come down well ahead of any reduction in fuel, and the possible closing down of furnaces would be curtailing the sources of supply and operate to the buyers' disadvantage. Moreover, stocks in hand are very low, and thus, although some of the foundries are far from busy, there is now rather more inclination to replenish. In their efforts to stimulate the demand, ironmasters have made another cut of 2s. 6d. per ton in the price of No. 3 Cleveland pig iron, which is now offered at 110s. No. 4 foundry is about 105s., and No. 4 forge 102s. 6d. The last-named figure would probably be shaded for a suitable contract. There is little No. 1 about, but the demand is also small, and moderate parcels can be obtained at anything between 120s. to 125s. per ton.

### Hematite Pig Iron.

A slight improvement is also reported in the East Coast hematite pig iron trade. There has been a little stirring of inquiry this week, and it would seem that some buyers are now disposed to come into the market again. Makers are quoting around 111s. to 112s. per ton for mixed numbers, but sellers, while adhering to these quotations for small lots, would no doubt be willing to break the figure against a substantial sale.

### Iron-making Materials.

The foreign ore trade is absolutely stagnant, and best Bilbao Rubio is purely nominal at 24s. c.i.f. Tees. The coke position remains steady. For good medium furnace qualities, 41s. 6d. per ton delivered at the works still represents a minimum figure.

### Manufactured Iron and Steel.

There is only a moderate amount of business being done in the manufactured iron and steel trade. The shipyard dispute is a restrictive factor, and specifications for shipbuilding material are conspicuous by their absence. Various cuts in quotations are announced this week. Steel ship plates are now down to £10, joists to £9 15s., angles to £9 10s., and rails to £10.

### The Coal Trade.

A slightly firmer tone prevails in the Northern coal market, but any alteration is very trifling, and is more a question of tone than actual alteration in values. There is developing just now an expanding volume of inquiry from abroad, which is not confined to any one country, but is spread over a fairly extensive field. The German demand is very heavy, and though, of course, there has not been any extensive buying, there are numbers of negotiations in progress which may result in considerable bookings for July to September. The German inquiries include one for 100,000 tons of best steams for shipment July to December next, and another for 100,000 tons of Durham unscreened steams, gas or coking coals. The Genoa gasworks—Italy—are in active negotiation for the purchase of six cargoes of prime Durham or Wear special gas coals to be shipped monthly, 5000 to 6000 tons per month, aggregating 30,000 to 36,000 tons, from July to December. Some of the tenders submitted have been on the basis of 28s. 6d. per ton f.o.b. The French State Railways are inquiring for 20,000 tons of Durham coking coals for shipment from July 15th to August 31st; while the Christiania gasworks—Norway—are also inquiring for about 30,000 tons of prime Durham gas coals for shipment in lots of 5000 tons monthly from October to March, 1924. Thus the forward prospects of the coal trade are very encouraging. The Northumberland steam coal section is fairly firm, with top prices indicated by the collieries, and as a rule only small quantities for disposal through merchants. Best and second screened and all brands of small are in good request. The Durham market is generally very steady for all first qualities of gas and coking coals, but

in the case of seconds and all South Durhams the market is patchy. Bunkers are quiet, but a trifle steadier. The position of the coke trade is more or less unaltered. Furnace and foundry makes are steady, while gas coke is steady to firm.

## SCOTLAND.

*(From our own Correspondent.)*

### Shipbuilding: Low Output.

THE labour trouble at the shipbuilding yards is further reflected in the depleted output for last month. During the first four months of the year prospects seemed brighter, but the advent of the labour dispute completely altered the situation. The number of vessels in the fitting-out basins is becoming smaller and smaller, and as each is completed more employees have to be discharged. New business also is being held up. A few orders were reported, but were chiefly for small craft, the most noteworthy contracts being one for two vessels of 5000 tons deadweight for the Adelaide Steamship Company, to be built at Dalmuir, and one for a motor ship of 8000 tons for Messrs. James Chambers and Co., Liverpool, to be built at Dundee. The output for June was thirteen vessels of 8512 tons aggregate, which compares with sixteen vessels of 34,906 tons for the same month last year. For the six months to date, the output totals fifty-eight vessels of 145,657 tons, against sixty-two vessels of 167,493 tons for the same period last year. Apart from the Clyde, the tonnage launched in June only totalled 2900 tons. The only vessel of note launched during June was the Nurmahal, cargo steamer, 5450 tons, built at Scotstoun, for the Asiatic Steam Navigation Company, Limited, London.

### Pig Iron Inactive.

The pig iron market is devoid of fresh business, either for home or export delivery, and the easier tendency in the market is more pronounced. The demand for hematite is extremely poor, and the outlet for foundry is almost as small. A further drop in prices is anticipated.

### Dull Conditions in Steel and Iron.

Steel and iron producers are meeting with little encouragement. The output of steel is diminishing as old contracts are completed, and the outlook is far from favourable. Plates and sectional materials are receiving little attention, consumers entertaining absolutely nothing beyond actual requirements. The dearth of new business is so marked all round that although continental offerings of cheaper materials are on the increase, these are receiving scant attention. Steel sheets are still fairly busy, but the lighter gauges alone are entering into new business to any extent. The position at the bar iron works is unimproved. Practically nothing is being bought at present, either in iron or re-rolled steel. As a rule, even in quiet times there is extra activity before the holidays, but at the time of writing there is no sign of any "rush" this year.

### Coal.

The outlook in the export department of the Scotch coal trade has improved a little during the past few days. The present level of prices has evidently made more appeal to buyers, and inquiries for most descriptions of round coal for export are more numerous. Washed nuts present the strongest feature in the market, with treble nuts the strongest quality. Shipments were well maintained, with coastwise clearances bulking largely, but there is now a larger number of vessels in port for foreign destinations. Aggregate shipments amounted to 330,911 tons, against 336,110 tons in the preceding week and 279,845 tons in the same week last year. The home demand for all classes of fuel is very restricted. Industrial requirements are extremely small, and household and municipal orders are at their lowest ebb. Round coals are fairly steady in price, while washed materials are tending upwards.

### Shortage of Labour in Fifeshire.

In almost every district in Fifeshire there is a shortage of skilled miners; in fact, it is said that in the whole of West Fife no able-bodied miner is unemployed. Colliery managers are constantly asking for men, and it seems certain that some hundreds could be engaged.

### Miners' Wages Increased.

The wages of miners in Scotland during July and August will be 178.4 per cent. above the 1888 basis rates, showing an approximate increase of 1s. 10d. per shift. It is calculated that men working at the face, including coal-cutting machiners and conveyor workers, earned an average of 12s. to 12s. 6d. per day during May and June, to which will fall to be added the increase mentioned above. Thus the accountants' report in accordance with wages agreement shows an increase in wages from 7 to 9 per cent. higher than that demanded by Mr. Adamson's Minimum Wages Bill, rejected in the House of Commons last week.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

### Coal Trade Position.

THERE has not been a great deal of change in the coal trade position as compared with a week ago, except that the tone is steadier and prices are not moving downward. The fall has been arrested, temporarily at any rate. More business has come along, and many collieries which were beginning to feel the need of prompt stems and were reducing their prices in order to attract business, have filled up and the majority of undertakings are fairly well off for the time being. The question whether this will last for long is a moot one, but most colliery salesmen are optimistic regarding the outlook, and see no reason to discount values for later delivery. Most salesmen will be well satisfied if the market maintains its present level throughout the month, feeling sure that the tendency afterwards will be towards improved conditions, in view of the probability that Germany will by that time be in the market for further supplies. There is no doubt that at the moment a fair amount of orders are being withheld owing to the foreign exchanges being so inimical to operations. As regards the Egyptian State Railways' contract, referred to last week, it is now known that they contracted for about 150,000 tons of locomotive coals from this district, and the business was secured by Messrs. Furness, Withy and Co. and Messrs. Evans and Reid, the former firm securing the greater part of the business.

### Miners' Wages.

Reference was made last week to the prospects of the miners in this district getting an increase in their wage rate for the months of July and August, and it was estimated that this advance would probably be about 12 per cent. An official statement has since been issued, and shows that the miners are to receive 9.62 per cent. more than the minimum of 28 per cent. on the 1915 standard rates. This is the first time since January, 1922, that the minimum has been exceeded. The actual percentage payable is 37.62 per cent. on the 1915 standard rates, which compares with 26.05 per cent. under the previous audit, or an increase of 11.57 per cent., which is calculated on the standard rates, which are 50 per cent. higher than they were in 1914. If the advance had been payable on the 1914 standard rates, it would have been equivalent to an advance of no less than 17.35 per cent. The percentage of 37.62 on the 1915 standard rates is equivalent to 106.43 per cent. on the standard rates paid in 1914. There are prospects of a further improvement in wages under the next audit. There has recently been a reaction in the current prices of coal on the market, but it is anticipated that the accountants' certificate for May and June, which months regulate the wages for September and October, will show an increase in the surplus over that for March and April, and therefore a further advance in the percentage will be payable on the standard. A good deal of dissatisfaction was felt that as the increase in the wage rate for the current month and August was not more than 9.62 per cent. above the minimum, the lower-paid workmen would not benefit, owing to their being in receipt of the subsistence wage allowance under the Buxton award. The matter came up for consideration at a meeting of the Coal Conciliation Board at Cardiff on Tuesday, when the owners made the workmen representatives an offer of an increase of 4d. per day, or 2s. per week of six days. The men's leaders expressed their dissatisfaction with this, as they thought that the men should receive the full benefit of the advance in wages in addition to the subsistence wage allowance, but they decided to accept the owners' terms.

### Dock Strike.

For the first time for many months a rather serious strike has broken out at the Bute Docks at Cardiff. Under the Shaw agreement the general cargo workers at the docks were to have their wages reduced by 1s. to 10s. per day in the case of time workers, and by 5 per cent. for piece workers as from July 2nd. The men, however, contend that the decrease is not justified, as they challenge the accuracy of the contention that there has been a decline of 10 per cent. in the cost of living. The strike commenced on Monday by the men engaged in the discharge of pit props from the steamer Viborg, suspending operations, and they immediately went round the docks persuading men working on other ships to give up work. Before the day was over there were over a thousand men idle, including those engaged in the discharging of pitwood, grain and general cargo. The strike was not countenanced by the officials of the Transport and General Workers' Union, whose advice was ignored in the matter. On Tuesday the unofficial strike was strengthened by about 300 iron ore men joining those already out; in fact, all the men engaged in the import trade are idle. Meetings of the men are to be held, and it is hoped that they will listen to reason on the part of their own officials, though it is to be feared that the strike may extend to the workers at the other South Wales ports who are affected by the Shaw agreement.

### Three-shift Question.

When the partial third shift came into operation for the loading of coal at South Wales ports, the fear was expressed that the concession on the part of the workmen was belated, and that it would be found that the necessity for it was practically gone, or, at any rate, its operation would come at a time when the need for it was less pressing, owing to the extreme demand for coals having eased down. This now turns out to be the case, and the men are getting dissatisfied. Last week-end a conference of coal tippers, held at Cardiff, regarding the working of the three-shift system, initiated steps for getting a reversion to the two-shift system. There is to be another discussion of the matter this coming week-end.

### Current Business.

There has been a little more activity in steam coals during the past week, and the tone on the whole is steadier. Best Admiralty large coals are quoted at 30s. to 32s., and second Admiralty large are obtainable round about 29s. to 30s. Dry coals are very well placed for the time being, and Monmouthshire qualities are in a slightly better position, while small coals of superior sorts continue to be about 22s. to 23s. Coke is rather quiet, and the inquiry for patent fuel is on rather moderate lines. Anthracite coals are for the most part firm, the only exception probably being rubbly culm, which is more freely obtainable at 16s. 6d. Anthracite large and sized qualities are scarce and firm.

# Latest News from the Provinces.

## WALES AND ADJOINING COUNTIES.

### Cargo Workers' Strike.

ABOUT 2000 men are still idle at Cardiff, and on Wednesday 1500 men at Barry came out, thus paralysing the import trade at the Barry Docks. At Swansea the dockers held a mass meeting on Wednesday and expressed keen resentment at the proposal to bring about a reduction in wages, but decided loyally to abide by the agreement and to adopt constitutional methods for bringing about its termination.

# American Engineering News.

*(From our own Correspondent.)*

## DIAMOND DRILLS FOR OIL WELLS.

THE diamond drill has not yet been able to compete with the rotary drill in drilling producing wells, but a large drill of this type of special design has been used successfully for such work. This drill makes a 3in. hole and can work up to a depth of 5000ft. It is equipped with a double hydraulic cylinder, which gives it great lifting or driving power, and its feed is 30in., as compared with 12in. for most types of diamond drills. The apparatus is so planned that the drill can be used to rotate a fish-tail bit, as in a rotary drill, when drilling in soft formation, changing to the diamond bit for harder formation, or where it is desired to secure cores. It is known as the Longyear drill. In oil work the general uses of the ordinary diamond drill are found in the drilling of numerous shallow holes to ascertain the sub-surface contour, and in drilling holes of smaller diameter than required for production wells, in order to obtain information as to the character of the oil sand and the quality of the oil. For the former purpose light portable outfits, driven by petrol motors and taking 1in. cores, are generally used. These core drillings give much more reliable results than churn drills, while the greater lightness of the diamond core-drilling apparatus makes the work simpler and cheaper.

## LOW-TEMPERATURE COKING PLANT.

IN connection with the new River Rouge steel plant at Detroit, the Ford Motor Company will build the first unit of a new type of coking plant designed to handle, eventually, 4000 tons of raw coal daily. About 1800 tons of coke will be pulverised for use as fuel under the largest boilers now using pulverised fuel. About 1200 tons of the coke will be ground and mixed with coal of high volatility, and then delivered to high-temperature ovens producing metallurgical coke for use in the steel works. Another coke plant is being built at the Canadian plant of the Ford Company, to handle 400 tons daily. The structure consists of a clay refractory furnace, 44ft. to to 54ft. long, having two longitudinal arched distilling chambers 14ft. wide and 6½ft. high at the crown. Cast iron U-shaped transverse flues connect the heating and exhaust chambers, the horizontal legs being submerged in a bath of molten lead. Coal is carried through the heating chamber on plate conveyors, reaching a temperature of 1200 deg. Fah., and is then again passed through at half the former speed. It is estimated that for each ton of coal there will be produced 8000 cubic feet of gas (calorific value 700 B.Th.U.), 5 gallons of motor fuel, ammonia from the gas and condensation liquor, and 25 to 30 gallons of very light tar. This tar will produce 5 gallons of motor fuel, 3 gallons of creosote oil, 2 gallons of lubricating oil and 10 lb. of lubricating grease, leaving a residuum of heavy oil or tar that can be used as fuel. The coke will be high in carbon and suitable to be burned direct on chain-grate furnaces, briquetted for domestic use or pulverised for furnace fuel.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon, July 2nd, Sir James Crichton-Browne, treasurer and vice-president, in the chair. The death of Sir James Reid, Bart., was reported to the meeting and a resolution of condolence with the family was passed. Mr. R. N. Lennox was elected a member.

IRON AND STEEL INSTITUTE.—Sir William H. Ellis, G.B.E., D.Eng., managing director of John Brown and Co., Limited, has been nominated by the Council of the Iron and Steel Institute for election as president of the Institute next year. He will assume office at the May meeting of the Institute in 1924, in succession to Mr. Francis Samuelson, of Thirsk, who has been president since 1922.

RAIL SAWS.—We have received from Fry's (London), Limited, of 46, Upper Thames-street, E.C. 4, a sample of a new type of hack saw blade which has been specially produced for cutting tramway and railway metals. The peculiarity of the saw lies in the arrangement of the teeth, which face in opposite directions in groups of four, so that they cut in either direction. The makers claim that the saw will go on cutting even when the points of the teeth are blunt. The saw, which is British made, is stocked in lengths of 12in., 14in., and 16in. by 18 and 16 gauge thickness.

THE INSTITUTE OF METALS: AUTUMN MEETING.—The annual autumn meeting of the Institute of Metals will be held this year in Manchester on September 10th to 13th. It will open with the second annual autumn lecture, to be delivered by Lieut.-Colonel Sir Henry Fowler, K.B.E., on "The Use of Non-ferrous Metals in Engineering." The lecture will be a popular one, and is open to the public, tickets being obtainable from Mr. G. Shaw Scott, M.Sc., 36, Victoria-street, London, S.W. 1. The mornings of September 11th and 12th will be devoted to the reading and discussion of papers. After an official luncheon on September 11th, visits will be paid to several large works in the vicinity of Manchester, and in the evening there will be a reception at the University, when the new metallurgical laboratories will be officially opened. Following the conclusion of the business side of the programme on September 12th, the afternoon of that day will be devoted to a trip along the Manchester Ship Canal, and in the evening there will be a smoking concert at the Midland Hotel. A trip to Chester has been arranged for September 13th, this excursion also including a launch trip up the river Dee.

# Current Prices for Metals and Fuels.

## IRON ORE.

| | |
|---|---|
| N.W. COAST— | |
| Native | 26/- |
| (1) Spanish | 24/- |
| (1) N. African | 24/- |
| N.E. COAST— | |
| Native | — |
| Foreign (c.i.f.) | 24/- |

## PIG IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| (2) SCOTLAND— | | |
| Hematite | 5 17 6 | — |
| No. 1 Foundry | 5 12 6 | — |
| No. 3 Foundry | 5 7 6 | — |
| N.E. COAST— | | |
| Hematite Mixed Nos. | 5 11 0 | 5 11 0 |
| No. 1 | 5 12 0 | 5 12 0 |
| Cleveland— | | |
| No. 1 | 6 0 0 | 6 0 0 |
| Silicious Iron | 6 0 0 | 6 0 0 |
| No. 3 G.M.B. | 5 10 0 | 5 10 0 |
| No. 4 Foundry | 5 5 0 | 5 5 0 |
| No. 4 Forge | 5 2 6 | 5 2 6 |
| Mottled | — | — |
| White | — | — |
| MIDLANDS— | | |
| (3) Staffs.— | | |
| All-mine (Cold Blast) | 13 0 0 | — |
| North Staffs. Forge* | — | — |
| „ „ Foundry | 5 2 6 | — |
| (3) Northampton— | | |
| Foundry No. 3 | 5 0 0 | — |
| „ Forge | 4 10 0 | — |
| (3) Derbyshire— | | |
| No. 3 Foundry | 5 0 0 | — |
| Forge | 4 12 6 | — |
| (3) Lincolnshire— | | |
| Basic | 5 5 0 | — |
| Foundry | 5 2 6 to 5 5 0 | |
| Forge | 5 0 0 | — |
| (4) N.W. COAST— | | |
| N. Lancs and Cum.— | | |
| Hematite Mixed Nos. | 6 5 0† | — |

## MANUFACTURED IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| SCOTLAND— | | |
| Crown Bars | 12 0 0 | — |
| Best „ | — | — |
| N.E. COAST— | | |
| Crown Bars | 12 0 0 | — |
| Tees | 10 0 0 | — |
| LANCS.— | | |
| Crown Bars | 12 0 0 | — |
| Second Quality Bars | 11 5 0 | — |
| Hoops | 15 0 0 | 14 15 0 |
| S. YORKS.— | | |
| Crown Bars | 12 10 0 | — |
| Best „ | 13 10 0 | — |
| Hoops | 15 10 0 | — |
| MIDLANDS— | | |
| Crown Bars | 12 0 0 to 12 10 0 | |
| Marked Bars (Staffs.) | 14 10 0 | — |
| Nut and Bolt Bars | 11 0 0 to 11 5 0 | |
| Gas Tube Strip | 12 15 0 to 13 0 0 | |

## STEEL.

| | (6) Home. £ s. d. | (7) Export. £ s. d. |
|---|---|---|
| (5) SCOTLAND— | | |
| Boiler Plates | 13 0 0 | — |
| Ship Plates, ¼in. and up | 10 5 0 | — |
| Sections | 10 0 0 | — |
| Steel Sheets, 3/16in. to ¼in. | 12 10 0 | — |
| Sheets (Gal. Cor. 24 B.G.) | — | 18 17 6 |

## STEEL (*continued*).

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| N.E. COAST— | | |
| Ship Plates | 10 0 0 | — |
| Angles | 9 10 0 | — |
| Boiler Plates | 14 0 0 | — |
| Joists | 9 15 0 | — |
| Heavy Rails | 10 0 0 | — |
| Fish-plates | 14 0 0 | — |
| Channels | 9 5 0 | — |
| Hard Billets | 10 15 0 | — |
| Soft Billets | 10 0 0 | — |
| N.W. COAST— | | |
| BARROW— | | |
| Heavy Rails | 9 10 0† | — |
| Light „ | 12 0 0† | — |
| Billets | 11 0 0† | — |
| MANCHESTER— | | |
| Bars (Round) | 11 10 0 to 11 15 0 | |
| „ (others) | 10 5 0 to 10 15 0 | |
| Hoops (Best) | 15 5 0 | 15 0 0 |
| „ (Soft Steel) | 13 15 0 | 13 10 0 |
| Plates | 10 5 0 to 10 10 0 | |
| „ (Lancs. Boiler) | 13 10 0 | — |
| SHEFFIELD— | | |
| Siemens Acid Billets | 13 0 0 | — |
| Bessemer Billets | 13 10 0 | — |
| Hard Basic | 10 15 0 | — |
| Intermediate Basic | 10 10 0 | — |
| Soft Basic | 8 10 0 | — |
| Hoops | 12 15 0 to 13 5 0 | |
| Soft Wire Rods | 13 0 0 | — |
| MIDLANDS— | | |
| Small Rolled Bars | 10 10 0 to 10 15 0 | |
| Billets and Sheet-bars | 8 0 0 to 8 10 0 | |
| Gas Tube Strip | 11 0 0 to 11 10 0 | |
| Sheets (20 W.G.) | 11 10 0 to 12 0 0 | |
| Galv. Sheets, f.o.b. L'pool | 18 10 0 to 19 2 6 | |
| Angles | 10 0 0 | — |
| Joists | 10 0 0 | — |
| Tees | 11 0 0 | — |
| Bridge and Tank Plates | 10 15 0 to 11 0 0 | |

## NON-FERROUS METALS.

| | |
|---|---|
| SWANSEA— | |
| Tin-plates, I.C., 20 by 14 | 23/1½ |
| Block Tin (cash) | 177 15 0 |
| „ (three months) | 179 5 0 |
| Copper (cash) | 64 17 6 |
| „ (three months) | 65 7 6 |
| Spanish Lead (cash) | 23 15 0 |
| „ (three months) | 23 7 6 |
| Spelter (cash) | 27 17 6 |
| „ (three months) | 28 10 0 |
| MANCHESTER— | |
| Copper, Best Selected Ingots | 69 0 0 |
| „ Electrolytic | 72 0 0 |
| „ Strong Sheets | 98 0 0 |
| „ Loco. Tubes | 0 1 1½ |
| Brass Loco. Tubes | 0 1 0 |
| „ Condenser | 0 1 2½ |
| Lead, English | 25 10 0 |
| „ Foreign | 24 5 0 |

## FERRO ALLOYS.

*(All prices now nominal.)*

| | Per Ton. | Per Unit. |
|---|---|---|
| Tungsten Metal Powder | 1/11 per lb. | |
| Ferro Tungsten | 1/5½ per lb. | |
| Ferro Chrome, 4 p.c. to 6 p.c. carbon | £23 0 0 | 10/6 |
| „ 6 p.c. to 8 p.c. „ | £21 0 0 | 8/- |
| „ 8 p.c. to 10 p.c. „ | £20 0 0 | 8/- |
| „ Specially Refined | | |
| „ Max. 2 p.c. carbon | £50 0 0 | 18/- |
| „ „ 1 p.c. „ | £60 0 0 | 21/- |
| „ „ 0.75 p.c. carbon | £70 0 0 | 22/6 |
| „ carbon free | 1/6 per lb. | |
| Metallic Chromium | 4/6 per lb. | |
| Ferro Manganese (per ton) | £18 for home, £20 for export | |
| „ Silicon, 45 p.c. to 50 p.c. | £13 0 0 scale 5/- per unit | |
| „ „ 75 p.c. | £21 0 0 scale 6/- per unit | |
| „ Vanadium | 16/9 per lb. | |
| „ Molybdenum | 9/6 per lb. | |
| „ Titanium (carbon free) | 1/1 per lb. | |
| Nickel (per ton) | £130 | |
| Cobalt | 12/- per lb. | |
| Aluminium (per ton) | £82 to £100 | |

(British Official.)

## FUELS.

| | SCOTLAND. Inland. | Export. |
|---|---|---|
| LANARKSHIRE— | | |
| (f.o.b. Glasgow)—Steam | | 21/6 |
| „ „ Ell | | 22/6 |
| „ „ Splint | | 23/6 to 26/- |
| „ „ Trebles | | 24/6 |
| „ „ Doubles | | 23/- |
| „ „ Singles | | 21/6 |
| AYRSHIRE— | | |
| (f.o.b. Ports)—Steam | | 21/6 |
| „ „ Splint | | 24/- |
| „ „ Trebles | | 24/6 |
| FIFESHIRE— | | |
| (f.o.b. Methil or Burntisland)—Steam | | 20/9 to 25/9 |
| Screened Navigation | | 30/- |
| Trebles | | 25/- |
| Doubles | | 22/9 |
| Singles | | 21/9 |
| LOTHIANS— | | |
| (f.o.b. Leith)—Best Steam | | 23/- |
| Secondary Steam | | 21/3 |
| Trebles | | 25/- |
| Doubles | | 22/9 |
| Singles | | 21/9 |
| ENGLAND. | | |
| (8) N.W. COAST— | | |
| Steams | | 31/6 |
| Household | | 46/8 to 57/6 |
| Coke | | 48/- |
| NORTHUMBERLAND— | | |
| Best Steams | | 26/6 to 28/- |
| Second Steams | | 25/- to 26/- |
| Steam Smalls | | 16/6 to 18/6 |
| Unscreened | | 20/6 |
| Household | | 25/- to 28/- |
| DURHAM— | | |
| Best Gas | | 30/- |
| Second | | 26/6 to 28/- |
| Household | | 25/- to 28/- |
| Foundry Coke | | 60/- to 65/- |
| SHEFFIELD | Inland. | |
| Best Hand-picked Branch | 32/6 to 34/6 | — |
| Barnsley Best Silkstone | 28/- to 30/- | — |
| Derbyshire Best Brights | 25/6 to 27/6 | — |
| „ „ House | 23/- to 24/6 | — |
| „ „ Large Nuts | 20/6 to 22/6 | — |
| „ „ Small „ | 18/- to 20/- | — |
| Yorkshire Hards | 21/- to 23/- | — |
| Derbyshire „ | 20/- to 22/- | — |
| Rough Slacks | 12/- to 14/- | — |
| Nutty „ | 11/- to 13/- | — |
| Smalls | 7/- to 9/- | — |
| Blast-furnace Coke (Inland) | 31/- to 32/- | |
| „ „ (Export) | f.o.b. 40/- to 41/- | |

(9) SOUTH WALES.

| | |
|---|---|
| CARDIFF — | |
| Steam Coals: | |
| Best Smokeless Large | 30/- to 32/6 |
| Second „ „ | 29/- to 30/- |
| Best Dry Large | 30/- to 32/- |
| Ordinary Dry Large | 27/6 to 30/- |
| Best Black Vein Large | 29/- to 30/- |
| Western Valley „ | 28/- to 29/- |
| Best Eastern Valley Large | 27/- to 28/- |
| Ordinary „ „ | 26/- to 27/- |
| Best Steam Smalls | 23/- to 24/- |
| Ordinary „ | 19/- to 21/- |
| Washed Nuts | 30/- to 32/6 |
| No. 3 Rhondda Large | 34/- to 35/- |
| „ „ Smalls | 26/6 to 27/6 |
| No. 2 „ Large | 24/- to 25/- |
| „ „ Through | 22/6 to 23/6 |
| „ „ Smalls | 18/- to 20/- |
| Coke (export) | 50/- to 55/- |
| Patent Fuel | 34/- to 37/6 |
| Pitwood (ex ship) | 28/6 to 29/6 |
| SWANSEA— | |
| Anthracite Coals: | |
| Best Big Vein Large | 50/- to 55/- |
| Seconds | 45/- to 47/6 |
| Red Vein | 32/6 to 35/- |
| Machine-made Cobbles | 62/6 to 65/- |
| Nuts | 57/6 to 62/6 |
| Beans | 45/- to 47/6 |
| Peas | 25/- to 27/6 |
| Breaker Duff | 12/6 to 13/- |
| Rubbly Culm | 16/6 to 17/- |
| Steam Coals: | |
| Large | 26/- to 27/6 |
| Seconds | 23/6 to 26/- |
| Smalls | 18/- to 22/- |
| Cargo Through | 22/6 to 25/- |

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

* Quotations extremely high and nominal. † Latest quotations available.

# French Engineering Notes.

*(From our Correspondent in Paris.)*

### Trade Fluctuations.

AFTER remaining at a steady level for quite a long time, the value of the franc has further depreciated this week, and has caused a perturbation in trade which is having a bad effect upon business activity. So long as the exchange rate remained fairly constant, the situation was favourable to the giving out of orders, and the growing feeling of confidence encouraged a normal development of business. The sudden break has upset buyers' calculations. So uncertain is the future that most of those who were on the point of purchasing are holding back. The experience of the past few weeks has at least shown that whatever may be the exchange rate, it offers no impediment to trade so long as it shows some stability, but it is hopeless to expect any general recovery while there is the probability of considerable fluctuations. The only good effect of the fall in the value of the franc this week is to stimulate the foreign demand for raw and semi-manufactured material. The demand has been particularly good from Britain, which is believed to be making large purchases in view of a possible appreciation of prices following upon a reduced coke supply. It is certain that the French ovens are rapidly increasing their production, but the output will be wholly insufficient in the event of a falling off in the coke supplies from the Ruhr, and as wages in the Ruhr have been increased, and the price of English coke has been advanced by the exchange rate, it appears fairly certain that iron and steel prices will be quoted higher.

### Rolling Stock.

The situation of the locomotive and wagon builders is going from bad to worse. While the productive capacity is considerably larger than it was before the war, the requirements are very much less, on account of the huge quantity of rolling stock that was surrendered by Germany after the Armistice. Builders are now able to turn out more than a thousand locomotives a year, and yet the programme of the railway companies provides for the purchase of only 300 locomotives over a period of five years. The wagon firms can build annually about 2000 passenger coaches and from 30,000 to 35,000 trucks and vans. At present the companies are only purchasing about 50 per cent. of their pre-war requirements in coaches and 20 per cent. of goods wagons. Builders are employed largely upon repairs at a cost which is regarded in many cases as more than the vehicles are worth. The efforts made to secure business abroad have not been satisfactory, and a strong agitation is therefore being carried out to induce the railway companies to renew their locomotives and rolling stock, which would certainly contribute to the comfort of travelling. Under the new direction of the Conseil Supérieur, however, everything is sacrificed for the moment to finding a solution of the problem of how to make the railways pay.

### Continuous Brakes.

It was believed that the question of continuous brakes for goods trains had been definitely settled by the decision of the Conseil Supérieur des Chemins de Fer to recommend the adoption of the Westinghouse brake by the nations signing the Berne Convention. Officially there is no going back on that decision, which, it is understood, has been approved of by Belgium, but the attitude of Italy appears to be uncertain. At any rate, the unsuccessful competitors in the continuous brake tests do not intend to give up the struggle, and believe that there is some hope of making their claims heard when the matter comes up for international discussion. It is certain that the German brake possesses powerful interests in some countries, and now another brake is competing for supremacy on the ground of its more progressive action. It was invented by a Norwegian engineer, and the French rights having been acquired by one of the leading engineering firms, efforts are being made to obtain an official trial in this country. The decision of the Conseil Supérieur, however, is final, although it leaves the way open to the adoption of any system of compressed air brake that is interchangeable with the Westinghouse.

### Heavy Motor Traffic.

While there are practically no restrictions upon the speed and weight of tractors and motor lorries, it has been found necessary to consider the desirability of imposing additional taxes upon such vehicles in proportion to the wear and tear they cause to the roads. Although this country formerly possessed the reputation of possessing the best highway system in the world, the macadam roads are, nevertheless, of a construction that does not allow of their withstanding specially heavy traffic, and the deterioration of the thoroughfares in many parts of the country has been accentuated by the want of funds to keep them in a good state of repair. The Government therefore proposes to improve the construction of some of the national roads to allow of their resisting heavy motor traffic, and under the new scheme the cost will be borne partly by users of lorries and tractors, who will have to pay taxes according to weight and loads, and presumably also according to whether they run on rubber or iron tires.

### Regulating the Seine.

The project that was presented some time ago for creating a vast lake above Paris, with a view of storing water during the rainy period and returning it to the Seine in time of drought, so as to maintain a fairly regular level and thus prevent any danger of flooding, has been meeting with almost general approval, and the Paris Municipal Council has this week insisted upon the Government taking up the matter immediately. If the proposal is found practicable, it will greatly simplify the problem of traffic on the Seine, and may avoid the necessity of carrying out some of the expensive works in connection with the scheme for facilitating the navigation of boats of larger tonnage between Paris and Rouen.

# British Patent Specifications.

*When an invention is communicated from abroad the name and address of the communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

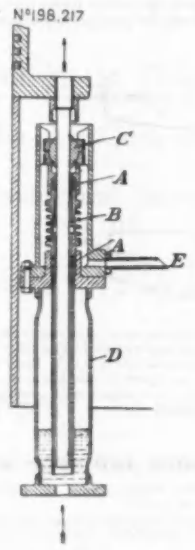
*Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.*

*The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.*

## INTERNAL COMBUSTION ENGINES.

198,217. June 2nd, 1922.—WATER COOLING PISTONS, Swan, Hunter and Wigham Richardson, Limited, Neptune Works, Walker, Newcastle-on-Tyne; F. Rowntree, 3, King's-road, Monkseaton; and P. Belyavin, 12, Otterburn-terrace, Newcastle-on-Tyne.

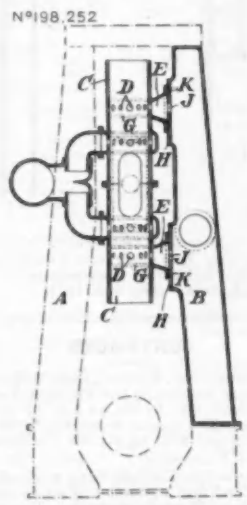
In this telescopic tube for introducing cooling water into the piston two stuffing-boxes A A are provided and have glands which are pressed apart by a spring B. Above them there is a




spherically seated wiper bush C. All these parts are mounted on a fixed air vessel D, while a drain for water leaking past the packings is provided at E.—*May 31st*, 1923.

198,252. July 13th, 1922.—SCAVENGING TWO-STROKE ENGINES, The North British Diesel Engine Works (1922), Limited, South-street, Whiteinch, Glasgow, and J. C. MacCall Maclagan, Dunmore, Drumchapel, Dumbartonshire.

According to this invention the engine unit is supported by a frame or structure comprising two box-section columns A B in the same plane as the centre line of the moving cylinder C. One, B, of these columns is used as a receiver for the compressed air which is to be supplied to the moving cylinder C. That cylinder has near its outer ends scavenging air inlet ports D controlled by fixed piston-like combustion heads (not shown) as described in a specification taken out at an earlier date. These air




ports D are served by branch manifolds E projecting out on the side adjacent to the air receiving column B from the passage G around the air ports D. Flat guide faces H are formed on that part of the column B adjacent to the outer ends of the manifolds E and counterpart faces J on the manifolds bear on the guide faces H. The bearing faces J on the manifolds E are provided with packing rings K to prevent the escape of scavenging air, and it will be seen that the manifolds E act as guide slippers for the moving cylinder C and enable it to resist the lateral thrust imparted thereto owing to connecting-rod obliquity.—*May 31st*, 1923.

## TRANSFORMERS AND CONVERTERS.

198,215. May 30th, 1922.—TERMINALS FOR TRANSFORMERS, J. B. Hansell, 121, Eccles Old-road, Pendleton, Manchester; B. Beesley, 100, Newport-road, Chorlton-cum-Hardy, Manchester; and the Metropolitan-Vickers Electrical Company, Limited, 4, Central-buildings, Westminster.

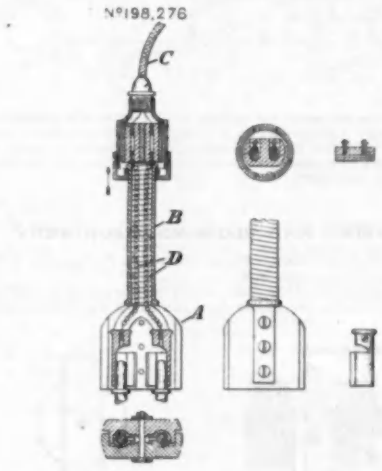
In electrical transformers as at present generally constructed for outdoor use all tappings for the windings are brought to the oil level, but only one from each winding is extended through the cover of the tank or casing. Consequently when it is desired to change a connection from one tapping to another the tank cover has to be removed. Transformer terminals in which a plurality of leads or tappings pass through a single insulating bushing have already been employed, but such terminals were not weather-proof. The object of the present invention is to provide a terminal which will be weather-proof. The terminal

comprises a substantially cylindrical insulating bushing A containing a plurality of sockets B insulated from each other and equidistantly spaced from a common centre with a removable cap C carrying a plug D adapted to make electrical connection with any one of the sockets. The removable cap is adapted to fit over the end of the bushing and to be rotated about an axis passing through the common centre of the sockets so that the plug can be caused to engage with any desired socket.—*May 31st*, 1923.

## ELECTRICAL APPLIANCES.

198,276. August 30th, 1922.—PLUG CONNECTORS FOR ELECTRIC FLAT IRONS, S. Ginsburg, 147, Bäckerstrasse, Zurich, Switzerland.

The inventor states that the lead-in wires of electric irons are liable to damage on account of the heat from the iron itself and constant flexure of the insulation. He thus extends the ordinary

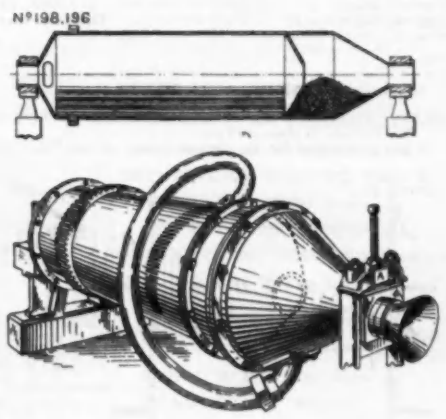



socket A by means of a piece of flexible metallic tubing B, on the top of which another plug and socket for the flexible wire C is fitted. The connections between the two plugs are made by wires D insulated with beads.—*May 31st*, 1923.

## CRUSHING AND GRINDING.

198,196. May 8th, 1922.—ROD MILLS, H. W. Hardinge, 551, Salisbury House, London, E.C. 2.

According to this invention a grinding mill comprises a cylindrical body of length greater than the diameter and a set of



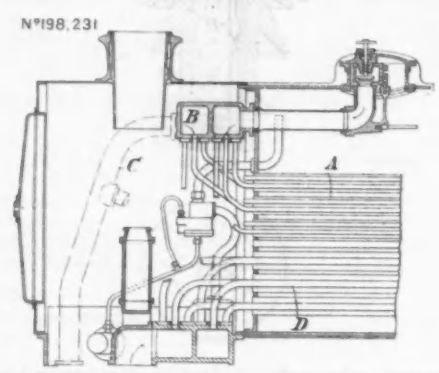

freely rolling rods, each of uniform cross section throughout its length, arranged lengthwise in the body portion. The cylindrical body is provided with outwardly tapering end plates which continuously guide the rods, whilst rolling, to the normal position

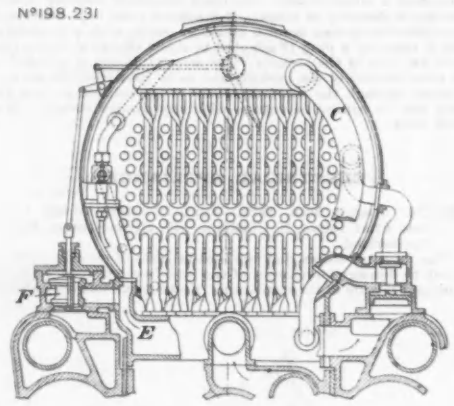
lengthwise without undue friction. The mill is provided at its outlet end with an extension chamber having a conical wall and containing balls, pebbles, or similar grinding elements. There may be provided a helical tube or conduit leading from the periphery of the extension chamber to a point within the cylindrical portion for the purpose of returning oversize for further grinding.—*May 31st*, 1923.

### LOCOMOTIVES.

198,231. June 21st, 1922.—SUPERHEATING IN COMPOUND ENGINES, *Ada Jouanno*, 147*a*, *Church-road*, *Hove*, *Sussex*.

The inventor proposes to superheat the steam in the normal fashion in a set of tubes A and take it from the header B and pipe C to the high-pressure cylinder of the engine. The exhaust from this cylinder is then superheated in the tubes D and con-



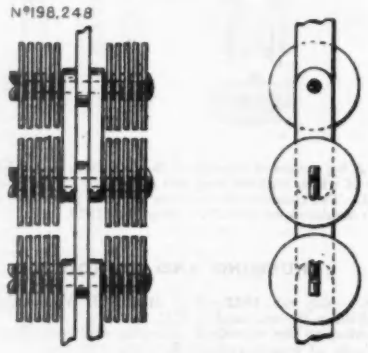




veyed to the low-pressure cylinders by way of the passage E. This passage is controlled by a valve F which is worked in synchronism with the main regulator G. Provision is made for circulating steam through the superheaters when the engine is idle.—*May 31st*, 1923.

### PUMPING AND BLOWING MACHINERY.

198,248. July 8th, 1922.—CHAIN PUMPS, A. Forbes, No. 2, The Grove, Hampstead, N.W. 3.

In this chain pump the chain proper carries all the weight and is not intended materially to help in raising the water. It is,

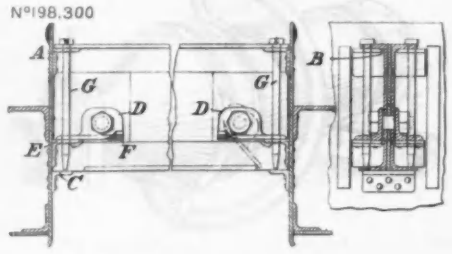



however, provided with bunches of thin discs, as shown, which carry up the water by capillary attraction. The discs may be made of non-corrodible material.—*May 31st*, 1923.

### SHIPS AND BOATS.

198,300. December 27th, 1922.—HATCHWAYS, F. Robinson, The Hollies, Wylam-on-Tyne.

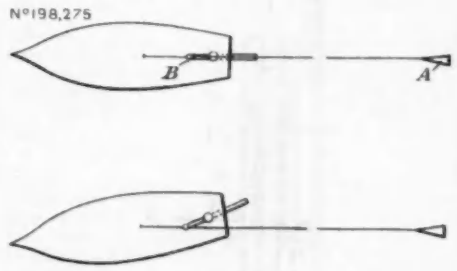
In this attachment for the portable beams of ships' hatchways




the beam is supported at the top by brackets A, the horizontal flanges being cut away at the centre as shown at B for the accommodation of the beam web. The beams are supported at the bottom by angle plates C. Pivotally connected to the beams are a pair of lugs D, which normally rest on brackets E, of which the horizontal flanges are slotted similarly to the brackets A to receive the ends of the beams. These brackets E are arranged to extend further outwards than the top brackets A. The lugs D are prevented from turning from their horizontal position in anti-clockwise direction by stops F, and they are so balanced that they have the tendency to tilt downwards in clockwise direction. The beams are secured in position by means of locking pins G. To remove a beam from the hatch the four locking pins are lifted out, whereupon the beams may be raised. During the raising of the beams the lugs D, when clear of the brackets E, tilt downwards at the front and occupy the position indicated by broken lines. The bottom flanges of the beam are cut away at the ends so that they will clear the brackets A and E when the beam is raised. In this position the lugs D are clear of the brackets A above, but still project over extensions of the brackets E. When the beams are replaced by lowering the lugs D will clear the brackets A, but will engage the extension and will thus be tilted back to their horizontal position to engage over the brackets E. The locking pins are then dropped into position to secure the beams.—*May 31st*, 1923.

198,275. August 29th, 1922.—AUTOMATIC STEERING APPARATUS, *The British Thomson-Houston Company, Limited, Crown House, Aldwych, London, W.C. 2.*

In order to check the yawing of a ship from side to side while she is under way, which yawing may be caused by carelessness on the part of the steersman, the inventors control the rudder by means of a drag. The specification shows an electro-hydraulic apparatus for operating the rudder under the influence of a relay controlled by the drag, but the principle is shown in the dia-

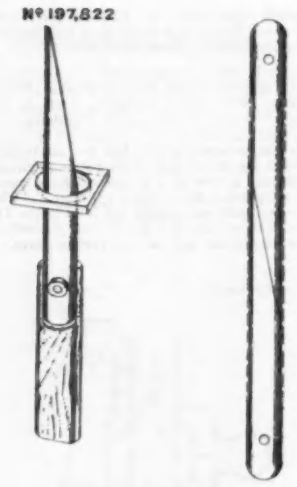



grams. The ship is laid on her course and held there long enough for the drag A to trail straight aft. The tiller is connected with the drag line at an intermediate point B. Then if the ship deviates from the set course, as shown in the lower diagram, the tiller is pulled over in the direction which will steer her back on to the course.—*May 31st*, 1923.

### MACHINE TOOLS AND SHOP APPLIANCES.

197,822. April 28th, 1922.—SAWS, J. Platt, Byron Works, Bouverie-road, Harrow.

The inventor says that this saw is specially suitable for cutting circular holes. Its form is fairly obvious in the drawings, which




show that the blade is bent transversely to the same radius as the hole to be cut. It is made from a double-edged straight saw, bent in a press and parted diagonally to provide a narrow end for starting the hole.—*May 24th*, 1923.

### CONTRACTS.

HOLDSWORTH AND SONS, Limited, Croft Boiler Works, Bradford, have recently received orders for eight Yorkshire boilers ranging in sizes from 13ft. by 6ft. to 24ft. by 9ft. 6in., and for seven Lancashire boilers ranging from 24ft. by 7ft.—this for the Leeds Corporation—to 30ft. by 9ft. 6in., including three 30ft. by 8ft. for the L.C.C.

ED. BENNIS AND CO., Limited, have received the order for the ash removal and dust extraction plant for the new electric generating station at Morwell, Australia. The plant comprises a complete pneumatic suction ash and dust extraction plant, including auxiliary and accessory equipments in two duplicate units, each unit being for the purpose of removing the ashes, soot and flue dust from a range of six water-tube boilers and chimneys, with three chain grates per boiler, being eighteen chain grates for each unit, or thirty-six grates for the complete plant.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—On the evening of Thursday last, the 28th ult., the annual conversazione of the Institution of Electrical Engineers took place at the Natural History Museum at South Kensington. Some 1500 members and guests were present, and they were received in the Central Hall of the Museum by Mr. Frank Gill, president, Mrs. Gill, and the Council of the Institution. By the permission of the trustees a large section of the Museum was open for inspection, and an opportunity was taken to see some of the more recent accessions. Added pleasure was given by a programme of music discoursed by the string band of the Royal Engineers in the Central Hall, while both in this hall and in an adjoining gallery an excellent vocal and instrumental concert was provided. In all respects the evening spent was a most enjoyable one.

## Forthcoming Engagements.

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

SATURDAY, JULY 14TH.

KEIGHLEY ASSOCIATION OF ENGINEERS.—Visit to the Sladen Valley Waterworks. Train leaves Keighley, M.R. Station, at 1.55 p.m.

WEDNESDAY, JULY 18TH.

INSTITUTION OF RAILWAY SIGNAL ENGINEERS.—At the Institution of Electrical Engineers, at 6.30 p.m. Paper on "The Theory of Interlocking," by Mr. J. S. Moore (member), to be read and discussed.

THURSDAY, JULY 19TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. Special general meeting of corporate members and associates. 5 p.m.

SATURDAY, JULY 21ST.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Council House, Sutton Coldfield. West-Midland District meeting. 2.30 p.m.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE ASSOCIATION OF CONSULTING ENGINEERS has elected Mr. J. Mitchell Moncrieff, M. Inst. C.E., M. Amer. Soc. C.E., as chairman for the ensuing year.

W. H. PEASE, A.M.I.M.E., A.F. Aer. Inst., asks us to state that he has moved his office from Hastings House, Norfolk-street, to 244, Abbey House, Victoria-street, London, S.W. 1.

VICKERS-PETTERS, Limited, of Ipswich, ask us to announce that they have appointed Mr. A. P. Laughland their Midland representative. His offices are situated at Union Chambers, Temple-row, Birmingham.

UNITED STRIP AND BAR MILLS, Limited, ask us to state that they have removed their London office from 15, Victoria-street, Westminster, S.W. 1, to St. Stephen's House, Victoria Embankment, Westminster, S.W. 1.

THE Committee of the Royal Automobile Club has appointed Commander F. P. Armstrong, R.N.V.R., as secretary and general manager of the Club, in succession to Sir Julian Orde, whose retirement took effect on May 31st last.

OWEN AND DYSON, Limited, of Rother Ironworks, Rotherham ask us to state that they have removed their London office from 15, Victoria-street, Westminster, S.W. 1, to St. Stephen's House, Victoria Embankment, Westminster, S.W. 1.

R. JENKINS AND CO., Limited, inform us that they have opened offices and showrooms at 15, Victoria-street, S.W. The Metallic Construction Company, Bridgewater Chambers, Brown-street, Manchester, has appointed Messrs. Jenkins representative in Lancashire and Cheshire.

WE are asked to state that Mr. E. P. Bennett, formerly joint general manager for Messrs. Simplex Conduits, Limited, Birmingham, has now joined the firm of Cargills, Limited, Balfour House, 119-125, Finsbury-pavement, London, E.C. 2, as manager and buyer for the Electrical and General Engineering Departments.

FLANNERY AND GIVEN, Limited, consulting engineers and naval architects, advise us that, owing to the building, in which they have been established for over forty years, being about to be demolished, they have removed to Drury Building, 21, Water-street, Liverpool. Their telephone number and telegraphic address will remain, *i.e.*, Bank 439 and "Drafting, Liverpool," respectively.

MESSRS. DOWDING AND DICKINSON, successors to G. W. Dowding and Co., late of 66, Victoria-street, London, S.W. 1, inform us of the retirement of Mr. Gordon W. Dowding from the business, the same having been acquired by the present partners, Messrs. C. J. Dickinson and A. G. Dowding. The firm has removed to more convenient offices in Windsor House, Victoria-street, London, S.W. 1.

SMEETON-WRIGHT FURNACES, Limited, which have recently removed from 56, Victoria-street, London, S.W., to larger offices at St Stephen's House, Victoria-embankment, London, S.W. 1, inform us that Mr. E. S. H. Corbett and Mr. S. H. Morden, of J. Whittall and Co., Limited, late of 9, Fenchurch-avenue, E.C., now of St. Stephen's House, have accepted seats on their Board, Mr. E. S. H. Corbett having been appointed chairman of directors.

## LAUNCHES AND TRIAL TRIPS.

ARCADIAN, ocean cruiser; reconditioned by Harland and Wolff, Limited; to the order of the Royal Mail Steam Packet Company; dimensions, 535ft. by 62ft. by 36ft. Engines, twin screws, each driven by a quadruple-expansion engine; constructed by the builders; trial trip, June 2nd.

DARDANUS, single-screw steamer; built by Workman, Clark and Co., Limited; to the order of the Ocean Steamship Company; dimensions, 459ft. 5in. by 58ft. 4in. by 32ft. 6in.; 7900 gross tonnage. Engines, one set of Brown-Curtis turbines; constructed by the builders; trial trip, June 13th.

HADRIAN, passenger and cargo steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Tyne Tees Steam Shipping Company, Limited; dimensions, 295ft. by 40ft. by 25ft. Engines, four-crank quadruple-expansion; constructed by the builders; trial trip, June 16th.

MAGDALENA, steel screw steamer; built by Craig, Taylor and Co., Limited; to the order of A. C. Lensen, of Terneuzen, Holland; dimensions, 337ft. by 48ft. by 24ft. 3in. Engines, 23½in., 39in., 64in. by 42in., pressure 180 lb.; constructed by Blair and Co., Limited, Stockton-on-Tees.

BERWINDMOOR, shelter-deck type, cantilever-frame built, coal-carrying steamer; built by Workman, Clark and Co., Limited, Belfast, to the order of the Berwindmoor Steamship Company, Limited, for the fleet of the Berwindwhite Coal Mining Company; dimensions, 435ft., 56ft., and 38ft. 6in. to the shelter deck; to carry about 10,000 tons deadweight. Engines, triple-expansion, 27½in., 45½in. and 76in. by 54in. stroke; constructed by the builders; the vessel was designed by Esplen and Sons, Limited, consulting engineers, Liverpool; launch, June 28th.

ERRINGTON DUNFORD, self-trimming collier; built by Swan, Hunter and Wigham Richardson, Limited, to the order of the Dunford Steamship Company, Limited; dimensions, 235ft., 36ft., and 16ft. 1in.; 1500 tons deadweight. Engines, triple-expansion, pressure 180 lb.; constructed by MacColl and Pollok, Limited; launch, June 29th.